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SCIENCE

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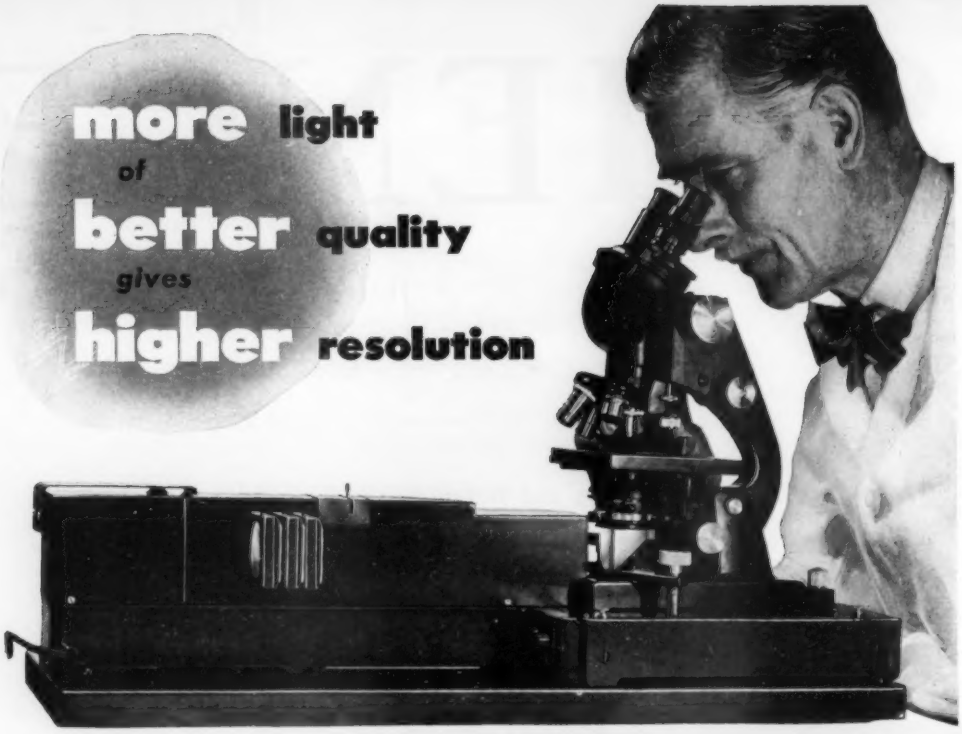

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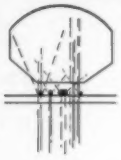

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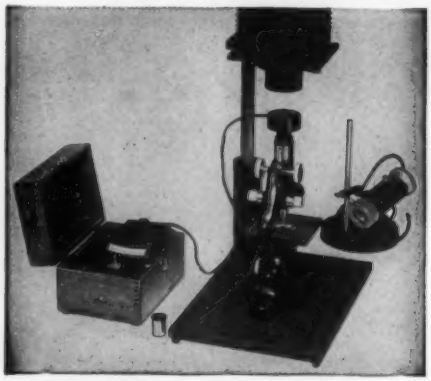

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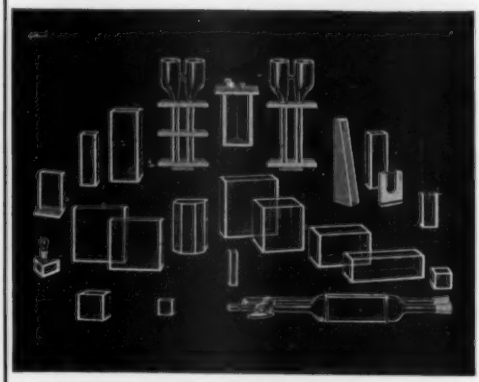

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THE July 4 issue, the first in Volume 116 of SCIENCE, is an appropriate place to list AAAS secretaries and Association committees. At this time of year the section secretaries are working on the program of the Annual Meeting, to be held in St. Louis Dec. 26–31, and their addresses are of importance to members who wish to participate in the program. The list of elected officers may be found on page 3 (advertising section) of the January 4 issue of SCIENCE. Administrative officers are:

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The work of the several committees is directed by the Executive Committee, comprising the three presidents, the Administrative Secretary, and eight members elected by the Council (SCIENCE, 115, 3 [advertising section, Jan. 4, 1952]). Efficiency within the Executive Committee is enhanced by means of subcommittees—namely, Budget (Detlev W. Bronk, *chairman*); Building (John R. Dunning, *chairman*); Publications (Fernandus Payne, *chairman*). Other Association committees, charged with important tasks, include Finance (Frederick P. H. Siddons, *chairman*); Affiliation and Association (L. V. Domn, *chairman*); Bylaws and Constitution (Kirtley F. Mather, *chairman*); Evaluation of Scientific Merit (Paul B. Sears, *chairman*); AAAS–George Westinghouse Science Writing Awards (Howard A. Meyerhoff, *chairman*); Thousand Dollar Prize (John R. Dunning, 1951 *chairman*); Theobald Smith Award (William S. McCann, *chairman*); Symposia at the St. Louis Meeting (Detlev W. Bronk, *chairman*); World Federation of Associations for the Advancement of Science (Kirtley F. Mather, *chairman*); Gordon Research Conferences (Herman Mark, *chairman*). Between Executive Committee meetings an Emergency Committee consisting of the three presidents acts on matters requiring prompt attention.

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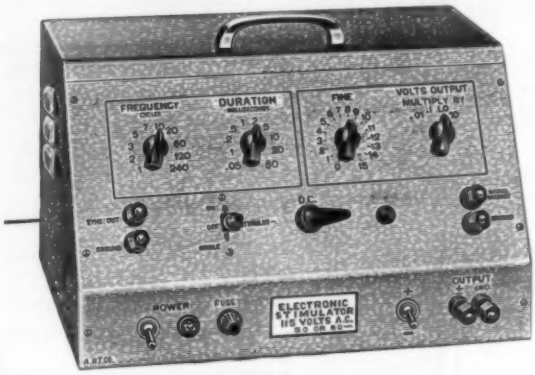

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Time and Trace Metals in Archaeological Sites[1,2]

V. P. Sokoloff and G. F. Carter
The Isaiah Bowman School of Geography, The Johns Hopkins University, Baltimore, Maryland

A MIDDEN IN THE WEATHERING ZONE is a geochemical anomaly undergoing dissipation. The anomaly here means a departure from the norm characteristic of the given climate and terrain. The departure has the following geochemical expressions:

1) *The amounts* of certain chemical elements are greater in the midden at zero time than in the corresponding nonmidden profiles and horizons.

2) *The distribution* of certain chemical elements in midden profiles is generally different from their distribution in nonmidden profiles, or "blanks," all other things being comparable.

3) *The initial form* in which certain chemical elements exist in the middens may be different from the form of their occurrence in the corresponding blanks.

The cause of the anomaly in question is man's refuse introduced in the weathering zone in the form of garbage and excreta. Depending on his diet and occupation, his refuse may be enriched with respect to copper, zinc, tin, lead, gold, manganese, and of course phosphorus, nitrogen, etc.

The anomalous amounts, distribution, and forms of some chemical elements in middens within the weathering zone tend to disappear in the course of time. The weathering and the soil-forming processes responsible for the normal or zonal distribution of the chemical elements in the blank profiles tend ultimately to produce similar levels and patterns in the midden, in the absence of catastrophic events. An orderly dissipation of the anomaly here visualized is necessarily a function of time. The rate of this dissipation is variable, tending to be relatively slow but depending on a large number of factors, such as the original character of the anomaly, parent materials of the soil, topography, climate, geological-geochemical history of the site, and others. If the dissipation rates of the anomaly can be established for the given climate and terrain, and if the existing levels and distribution patterns of certain critical elements in the midden profile can be ascertained, the extent of the departure of the existing anomaly from the blank may be an indication of the approximate age of the midden, under certain favorable conditions.

The working hypothesis here stated is an outcome of an earlier study in geochemical exploration[3] and of a number of observations related to our current studies of the rates of soil formation.[4] This hypothesis is designed chiefly for middens outside the suitability and the time range of the carbon 14 method. It is evident a priori that the hypothesis needs to be verified empirically, that it has potentially only a local usefulness, and that it will not yield any quantitative results even under nearly ideal conditions. Our aim, however, is not quantitative. We aim at an attainment of certain criteria that would help differentiate, for example, a midden 1000 years old from a midden 10,000 or 100,000 years old. The data here presented show that a difference of only 1000 years may be recognized in some datable midden profiles under certain conditions.

The Test Areas

Florida. A qualitative test of our supposition that the intensity of the midden anomaly, in the geochemical sense, tends to decrease with the midden's age was carried out as follows: Two middens differing only in age were located on a sandspit in the Melbourne Beach Area, Florida.[5] Both are situated on the sand ridge forming the present shore. Their geologic age, parent material, altitude (*ca.* 20′–25′ above sea level), vegetation, relief, and the microclimate are nearly identical. They were, and are, exposed to about the same kind of weathering solutions in post-Pleistocene time. Their original character was very nearly the same, judging by their area and the development of the midden layers. One of these middens, here designated as 1000–2000 B. P., is datable by the fragments of pottery it contains as belonging to the "Malabar Period."[6] The other midden, designated as 2000–3000 B. P., is dated by the potsherds as belonging to the "Fiber-Tempered or Orange Period."[7] The approximate reliability of such typological dating is here assumed and appears to be sustained by the geochemical data herein to be reported. To complete the set, a "blank" site ridge was located on the same ridge, comparable in every respect to the two middens, but showing no signs of human occupancy.

[1] We are indebted to the Wenner-Gren Foundation for Anthropological Research for the support of these studies and especially to Paul Fejos, director of research of the foundation, for his interest and encouragement of our work. We are also indebted to the Office of Naval Research for its interest in these studies.

[2] Based on an address presented at the Section E meetings of the American Association for the Advancement of Science, December 27, 1951, in Philadelphia.

[3] V. P. Sokoloff. *Geochemical Prospecting for Ore.* Denver: Colorado Mining Assoc. (1948); *Geochimica et Cosmochimica Acta*, **1**, 284 (1951).

[4] G. F. Carter, and V. P. Sokoloff. The Humisol (in preparation).

[5] We are greatly indebted to W. Edwards, Florida Geological Survey, for his interest and active cooperation in the project.

[6] Mr. Edwards identified the sherds and suggested the age and culture correlations.

[7] Culture and age for these periods are given also in Irving Rouse's "A Survey of Indian River Archaeology." *Anthropology*, (44–54), (1951).

Pedogenesis at all three sites was ascertained to be of one and the same kind—namely, a leaching with weathering solutions at a pH approaching 7.0,[8] in the nearly complete absence of the neutral salts. The net effect of such pedogenesis, including local and seasonal reversals in the movement of the weathering solutions, is to cause a noticeable downward migration of alumina, ferrous iron, and other metals of the iron group (Ni, Co, Cu, Zn, Mn, Cr).[9] A degree of sorting of the metals of the iron group accompanies pedogenesis. According to our view, based on the previously cited studies in geochemistry, the sorting of copper and zinc during this process is particularly diagnostic.

Although pedogenesis on the blank site is sufficiently advanced to have produced a humisol profile exceeding 20 inches in thickness, the presence of human refuse in both midden sites was sufficient to retard, if not to modify, the pedogenesis. The soil sections of the three profiles follow:

Blank site: 0 to 2″. Buff-white sand; fairly well sorted; some organic matter and many small fragments of shells.
2″ to 6″. Grayish-white sand; considerable amounts of humus and humus-bound iron; some undecomposed organic matter.
6″ to 13″. Pale yellow sand; relatively poorly sorted.
13″ to 20″. Yellow sand; poorly sorted; uniformly stained with iron rust.

1000–2000 B. P. midden site: 0 to 2″. Gray sand; loamy feel, caused by the high organic matter content; fairly well sorted; high content of humus-bound iron; small fragments of shells.
2″ to 6″. Dark-gray sand, as above; shell fragments less conspicuous; very high humus-bound iron.
6″ to 20″. Yellow sand; poorly sorted; uniformly stained with iron rust.

2000–3000 B. P. midden site: 0 to 2″. Gray, loamy sand; poorly sorted (well graded); some shell fragments; some humus-bound iron.
2″ to 6″. Gray sand; well graded; little humus-bound iron; a few shell fragments.
6″ to 20″. Yellow-white sand; poorly sorted; some shell fragments; no humus-bound iron.

The lower boundary of the two middens, shown above at 6 inches, is variable and may exceed 12 inches. Duplicate midden profiles, however, show the same sequence of the horizons and essentially the same trace metal distribution as the ones to be reported here.

Georgia, Kinchifoonie site.[10] This ancient midden is apparently preceramic (at least *ca.* 3000–4000 B. P.). The midden occupies an old land surface, possibly of Pliocene age. The exposed profiles contain a great thickness of a senile soil at their base, chiefly goethite-cemented quartz sand. The Kinchifoonie soil section is as follows:

0 to 6″; agricultural soil: Light reddish-brown sandy loam showing evidence of cultivation and of crop growth, probably also of repeated fertilization. Vestigial bleaching noticeable—characteristic of the forest-crop successions. A typical man-made horizon imposed on the humisol pedogenesis. Present vegetation: mixed grass.

6″ to 12″; bleached midden: Light reddish-brown, sandy loam; amorphous silica present. Weak crumbly structure, probably senile. Severely altered crude artifacts of flint present (resembling the European paleolithic), as well as a very few unaltered artifacts of a superior workmanship. The artifacts are apparently in place and are neither extrusive nor intrusive.

12″ to 28″; midden material: Less severely bleached than the overlying horizon. Reddish-brown, crumbly, sandy loam. The lower few inches of this horizon are cemented apparently by silica. Some charcoal present. Abundant severely altered primitive flint artifacts.

28″ to 100″; senile soil: Apparently a part of the "B" horizon of an ancient humisol. Compact red sand (quartz cemented by goethite), resembling the red sandstone of Macon Plateau, Ga. Numerous most severely altered primitive flint artifacts. Some filled rodent holes.

100″ to 106″; senile soil: Loose red goethite-sand mixture.

At base; yellow sand: Limonite, amorphous silica present; some secondary quartz may be present; locally iron-manganese concretions, gravel-sized.

The blank for the Kinchifoonie site was located within less than 0.5 mile of the midden, in the terrace of the same age cut by the same stream. The soil section in the blank was analogous to the previously described exposure, except that no midden materials were present and there were no other signs of human occupancy. The pedologic age of the blank may be more advanced in comparison with the midden profiles, judging by the intensity of the red colors in the weathered mass, a greater abundance of iron concretions, and other indications of the sorting of iron. The topsoil of the blank was an agricultural soil of the same kind as in the midden profile; it was underlain by a senile soil apparently identical with the 28-inch to 100-inch horizon of the midden profile, minus the intrusive and the extrusive materials; the base of the blank was the same as that of the midden.

Sample and Testing

Samples of approximately one pound each were taken from every horizon of the profiles described. The samples were grab composites in the vertical sequence of the soil section. They were stored in paraffin-coated cartons, screened through a 2mm pure iron sieve (Zn-free, Cu-free), mixed, and air-dried in the basement of Rogers House, The Johns Hopkins University, where the temperature is about 75° F

[8] Due apparently to the shell fragments in the weathering mass; pH of the atmospheric waters in this area is probably on the acid side of 7, perhaps 6 to 5.

[9] The nearly universal dispersion of iron and the iron group in nature is overlooked only too often. Even "pure" quartz sand, free from the heavy minerals, contains more than 10–20 ppm Fe by analysis and, as a rule, determinable traces of other metals.

[10] On Georgia Highway 19, about 2 miles northeast of Albany, Ga. Discovered in August 1951 by G. F. Carter. Described in Sokoloff's letter of Sept. 4, 1951, to Paul Fejos, director of anthropological research, Wenner-Gren Foundation.

and the relative humidity rarely exceeds 25 per cent in the winter.

Copper and zinc were determined by the dithizone procedures previously described.[11] Chloride and bicarbonate[12] were determined volumetrically, by titration of the aqueous extracts with 0.05*N* $AgNO_3$ and 0.05*N* H_2SO_4, respectively. The pH was gauged approximately, with "Hydrion" paper, in pastes, suspensions, and extracts of the soils.

The test results for copper and zinc are accurate probably to one significant figure only. A greater degree of accuracy is not required in the present search for differences in orders of magnitude, although the dithizone methods in general are capable of yielding two significant figures, or even three, provided one is willing to expend the time and energy necessary for such attainment.[13]

Copper, zinc, and many other metals occur in soils and soil materials in several different forms, both mineral and organic. They may be present in the crystal structures of some clay minerals, in combination with organic substances of different kinds, and, moreover, in various states of accessibility to the extracting solvents. In senile soils, especially, chiefly zinc but also copper may be present in states of occlusion by materials and surfaces still remaining to be ascertained. Finally, there may be extremely small amounts of ionic copper and zinc present locally or periodically in the soil solution.

A qualitative recognition of these different forms is relatively easy in the laboratory. Their separate quantitative estimation is generally so difficult as to be almost impossible. For example, a separate estimation of the organic forms requires an isolation of the organic fraction of the soil. There can be no assurance during any isolation procedure that the trace metal content of the organic fraction will remain as it was before the isolation. There seems to be no definite boundary between the soluble, the occluded, and the exchangeable forms. Nor is it possible to isolate the clay minerals from the soils without the risk of their becoming modified in the course of the isolation.

For these and many other reasons, it became necessary to employ rather arbitrary means of recognition of the different forms of copper and zinc in our materials. These means were as follows:

Extractable forms.[14] Zinc was extracted at pH 6.0 with 0.5*N* ammonium acetate at 70° C; copper was extracted at pH 1.0 with about 0.1*N* hydrochloric acid. A certain small fraction of the organic forms was probably extracted, alongside the occluded and the reagent-soluble forms.

[11] V. P. Sokoloff. *Mining Mag.* (Colorado School of Mines), 15 (Nov. 1950).

[12] The data are not included in this report.

[13] Even with these limitations, the dithizone methods are superior to the spectrographic procedures in their rapidity, sensitivity, and reliability. See V. P. Sokoloff. Project Notes on Dispersion of Lead and Zinc in Kokomo Mining District, Colorado. U. S. Geological Survey File Report (1948).

[14] No water-soluble forms of Cu and Zn could be detected in any of the materials. Under conditions of the tests, this means the water-soluble trace metal content was less than 0.5 μg/200 g (i.e., less than 0.0025 ppm).

Organic forms. The extracted and washed residues from the preceding treatment were digested repeatedly with small amounts of 30 per cent hydrogen peroxide and a few drops of strong hydrochloric acid. They were heated over an open flame, in silica dishes, so as to aid the oxidation, in the hope of avoiding losses caused by the volatile carbonyls of Zn and Cu, assuring good aeration of the samples. The residue was extracted as above, using acetate for zinc, and hydrochloric acid for copper. The metals were determined in the extract and designated as organic forms. These determinations are subject chiefly to negative errors (losses of the carbonyls, imperfect oxidation, incomplete extraction), and the results reported here, high as they may seem, are probably too low rather than too high.

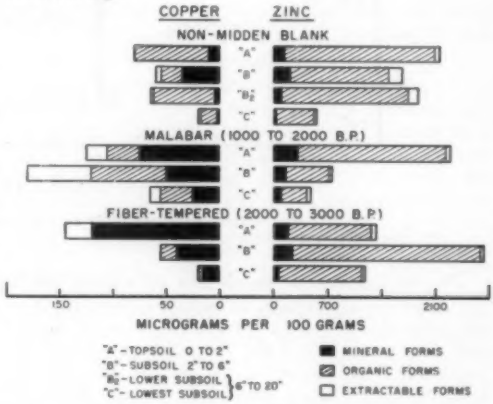

FIG. 1. Distribution of copper and zinc in two midden soil profiles of different age and in a nonmidden blank.

Mineral-bound forms. Following the removal of the organic forms, the residue was fused with potassium bisulphate in Vykor glass tubes, and the acid melt then examined for copper at pH 1 and for zinc at pH 6.0. The positive tests, which were ascribed to the mineral forms of these metals, as here reported, are probably too low, despite the possibility of some compensating errors. The tendency toward low results is due to the presence of unfused particles of quartz and, in some samples, of some dark mineral substance. The slight compensation may be due to some nonmineral forms carried through from the previous treatments. The sum of the extractable, organic, and mineral forms is shown as the total in Figs. 1 and 2. The orders of magnitude of these different forms are so different, however, as to justify a qualitative and perhaps a semiquantitative appreciation of the results.

Thus, the organic forms of zinc are preponderant over the others, indicating magnitudes often exceeding 1000 μg/100 g dry substance, as against 20–300 for the mineral forms, and 10–180 for the extractable. The organic forms of copper, however, range from 0 to 70 μg/100 g dry substance, as against 0–120 for the mineral and 0–60 for the extractable.

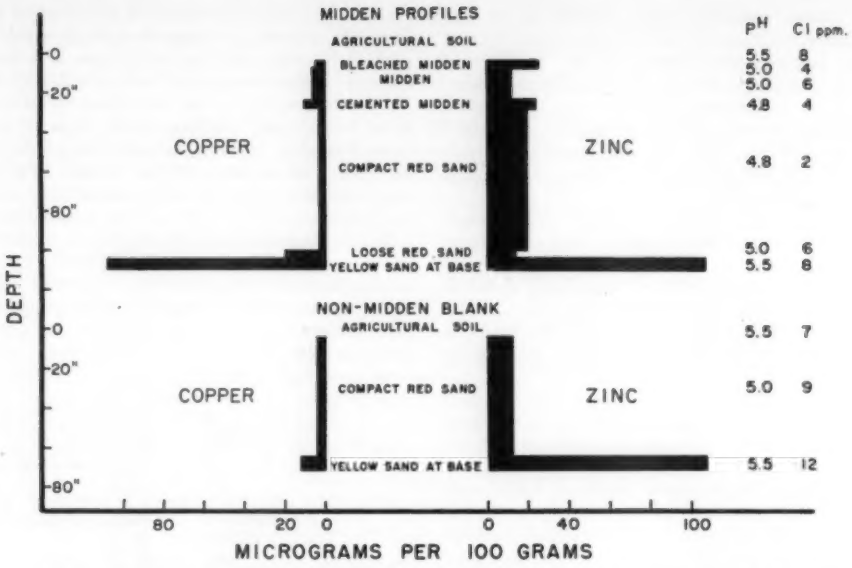

FIG. 2. Distribution of extractable copper and zinc in Kinchifoonie (preceramic) midden soil profiles and in nonmidden blank.

The fractionation of metals was not carried out in the Kinchifoonie profiles. It became evident early in the latter study that the extractable forms of copper and zinc are sufficient for the establishment of the geochemical expression of the midden. In contrast with the Indian River profiles, the organic forms of these metals were inconsequential here, except in the agricultural soil, and the mineral forms were nearly absent. If so, a most severe weathering and a very old age are indicated for the Kinchifoonie site, sufficient to have caused an almost complete decomposition of the clay minerals other than goethite, as well as an analogous decomposition or degradation of the metal-organic complexes.

These considerations made the geochemical investigations relatively easy at the Kinchifoonie. The collected materials were examined on the same day by the dithizone methods previously described,[15] and a preliminary report on the site was completed the same day.[16]

[15] We are indebted to Mr. Cordell, superintendent of schools, Albany, Ga., for the use of the laboratory space at the local high school. Reagents, glassware, and equipment are generally carried on all exploration trips. We are also indebted to A. B. Kelley, professor of archaeology at the University of Georgia, for his interest and cooperation in this study, for his cultural placement of the site, and for his generous aid in our preliminary work in Albany. We hope that Dr. Kelley will report the Kinchifoonie site in greater detail.

[16] There is no reason for delays, transportation, and storage of samples, and elaborately slow chemical procedures in the geochemical-archaeological reconnaissance here exemplified. As the Australian prospecting experience has shown, the entire laboratory gear for the purpose can be carried in a properly packed jeep, as well as the sampling tools, drafting instruments, typewriter and a filing case, camping equipment, etc.

RESULTS

The analytical data on Melbourne Beach and Kinchifoonie midden profiles presented in Figs. 1 and 2 are largely self-explanatory. The following supplementary observations are not included in the diagrams:

1) The pH of the Indian River profiles is 7.4 to 7.5 in the topsoil, 6.0 to 7.0 in the lowest horizons, and 6.5 to 7.0 in the intermediate horizons.

2) Chloride in the Indian River profiles was remarkably uniform—11–30 ppm in the topsoil and 4–11 ppm in all other horizons.

3) Triplicate midden profiles at the Kinchifoonie site are so similar, with respect to their trace metal distribution and other constituents, that only average values for all are shown in Fig. 2. The greatest variation exists only in the upper few inches of the agricultural soil.

A measure of exaggeration of details was not avoided in the diagrams. Thus the few micrograms indicated for certain forms in certain horizons are mere traces, detectable but too small to be shown on the scale.

The analytical data shown in Figs. 1 and 2 may be interpreted as follows:

1) Both blank and midden profiles are in the process of *rather severe leaching,* judging by the levels and the distribution of the extractable chloride. The chloride present in all these profiles is probably cyclic[17] and is introduced there by the atmospheric waters. The pH of the Kinchifoonie profiles is at the

[17] G. F. Carter and V. P. Sokoloff. Studies in Rates of Soil Formation in Chesapeake Bay Area. ONR Report (mimeo.).

common humisol levels, further characteristic of rather advanced leaching and weathering. The pH of the Melbourne Beach profiles is on the alkaline side of the humisol levels, probably on account of the still undecomposed shell fragments.

2) Both copper and zinc are noticeably concentrated in the topsoil materials, chiefly in their organic forms. Their high levels in the topsoil may be due, in the Kinchifoonie profiles, to man's agriculture, as well as to their chelation by the organic complexes. Geochemically the topsoil has little or no bearing on our problem.

3) Extractable copper in the subsoil midden materials, in relation to the corresponding blanks, is significantly higher but tends to approach the blank as the age of the midden profile is increased. Thus, the following comparison is possible:

Midden profile	Malabar	Fiber-tempered	Preceramic
Extractable copper in subsoil	10–60	0–8	0–8
Extractable copper in corresponding blank	0–3	0–3	ca. 5

The trends of extractable zinc in this connection are obscure. It is evident that a certain sorting of copper from zinc takes place, with time, in the course of the humisol pedogenesis. The Kinchifoonie profiles are nearly identical with the blank, as respects the extractable copper and, to a lesser degree, as respects the extractable zinc, if we disregard the local cementation in midden B horizon. It is evident also that the 1000–2000 B. P. (Malabar) Melbourne Beach midden profile is still anomalous with respect to its extractable copper, and that the 2000–3000 B. P. (fiber-tempered) and the preceramic midden profiles tend to resemble the blanks.

4) The organic and the mineral forms of both zinc and copper may be considered as showing trends not dissimilar from those of the extractable forms, but their significance needs to be ascertained by further work.

It is entirely possible, for example, that the mineral forms are chiefly clay-bound. If so, they tend to attain their maximum levels in the mature stage of the pedogenesis, whereupon they decline and tend to disappear in the senile stage. If so, the low mineral form-content is characteristic of both juvenile and senile stages of the pedogenesis.

It is possible also that the trace metals chelated by the organic fraction of the soil complex may serve as a reservoir, so to speak, for the clay-bound trace metals; it is possible that, as the age of the soil increases, the ratio of the organic to the mineral forms tends to decrease, from the juvenile to the mature stage of the humisol.

There are numerous other implications in this preliminary study. Further empirical and fundamental evidence is forthcoming. In the meantime, it appears that we have made a beginning in a relatively new method in archaeology.

A functional relationship is proposed between time and the establishment of normal trace metal dispersion patterns in midden soil profiles, under favorable conditions. It is shown conclusively that, in Florida, a period of 1000 or 2000 years is not enough to bring the distribution of trace minerals in a midden around to that in a comparable undisturbed site.

Certain forms of copper, in particular, appear to be well suited to serve as criteria of the pedologic age of midden soil profiles. The pedologic age may be a direct indicator of the chronologic age, all other things being comparable. These possibilities, however, are suggested rather than proved in the present study. The basis of the proposed correlation is empirical; namely, a study of three midden profiles datable archaeologically within one or two thousand years of each other but comparable with respect to their geomorphology, lithology, and pedogenesis. The comparisons are made also by reference to nonmidden profiles in the same environments and terrains. It may be stated even now that the establishment of the normal dispersion patterns for copper and, with less clarity, for zinc is probably a matter of several millennia, in the humisol terrains.

The problem is posed rather than solved in this preliminary investigation. Further detailed work is needed seriously to test our hypothesis. The geochemical approach to the approximate chronology of archaeological sites illustrated here may prove to be useful, especially for profiles outside the time range of the other methods of dating. Our endeavor is to arrive at the orders of magnitude of time rather than to aim at an "exact" dating, steering clear of any such archaeological delusion as the latter. At its best the geochemical method may enable us to tell the difference between a midden 1000 years old and another 10,000 (or 100,000) years old, but it certainly cannot distinguish the difference between 999 and 1001 years, all other things being favorable.

News and Notes

Conference on Teaching of Earth Science

THE third New England conference on earth science in secondary schools was held on March 15 at the Choate School, Wallingford, Conn. Those in charge of arrangements for the meeting were happy to accept the invitation from the Choate School, which for many years has had successful courses in earth science. The school has ample space for class meetings and laboratory work, and has excellent equipment, including maps, models, and representative collections of rocks and minerals.

The conference was attended by about 70 representatives of schools in Connecticut, Massachusetts, New York, and Pennsylvania. In the morning the visitors inspected instructional facilities at the Choate School, and particularly the building devoted to teaching the sciences. Some time was also given to an informal discussion of several topics, including the objective of secondary school courses in earth science. The afternoon and early evening were occupied with the following prearranged program: C. W. Wolfe, professor of geology, Boston University: Brief report on conferences of 1950 (at Boston) and 1951 (at Cambridge), with views and suggestions; Ray W. Tobey and A. Austin Meeks, Choate School: Teaching of Earth Science in Choate School; Frank B. Conklin, Deerfield, Mass.: The Course in Geology at Deerfield Academy; Merle A. Sturtevant, superintendent of schools, Shrewsbury, Mass.: Viewpoint of a Superintendent of Schools; T. Margaret Jamer, Board of Examiners, Board of Education, New York City: Earth Science in the New York City High Schools; David M. Delo, director, American Geological Institute, Washington, D. C.: How Can We Interest Promising High School Students in Earth Science?; John Hall Moss, Department of Geology, Franklin and Marshall College, Lancaster, Pa.; Roger Chaffee, Lancaster Day School; and Harold Platt, Germantown Friends School, Philadelphia: Progress in Introducing Geology into Southeastern Pennsylvania Schools; Samuel M. Brownell, professor of educational administration, Yale University, and president, New Haven Teachers College: Some Problems of Teacher Training in Earth Science; Richard J. Ordway, State Teachers College, New Paltz, N. Y.: Training of Teachers of Earth Science for Elementary Schools. John Hall Moss showed and explained a 16-mm Kodachrome motion picture, recently completed, to illustrate the training and work of geologists.

Those who have attended one or more of the New England conferences agree that the discussions have been highly profitable and are hopeful that similar cooperative effort may be stimulated in other parts of the country. Only a small percentage of secondary schools offer courses in earth science, but teachers of these courses find that the subject matter has a strong appeal to boys and girls. It is unfortunate that pupils in secondary and elementary schools do not have more generally available the opportunity to learn the meaning of the natural features they will see around them all their lives, and to gain some understanding of the earth and its mineral resources. Some courses in general science devote a little time to physical geography, but at best such limited treatment can present only a modicum of basic information and little if anything on elementary principles. As a result the great majority of high school graduates begin adult life with no scientific introduction to their physical world, and only a small minority of those who enter college have any concept of the part geology plays in a liberal education.

Some of the private schools offer excellent courses in earth science, at levels ranging from the high school years downward into lower grades. Such courses in public schools are much more exceptional, and those that are well established commonly owe their development to the devoted interest of an individual teacher, principal, or school superintendent. We learn with some surprise that the New York City high school curriculum has for many years included physiography. Until recently, however, the course was offered in only a small number of the schools. Current registrations show an encouraging increase. In 1950 the total population of academic high schools in New York City was about 150,000, with 5050 enrolled in earth science, or about 1 in 30. In 1951 the total registration increased to 172,390, and the enrollment in earth science to 7230, or about 1 in 24. In the same year 38,179 were enrolled in biology, 19,846 in chemistry, 9701 in physics, and 29,474 in general science.

School superintendents in communities that wish to initiate courses in earth science report difficulty in finding properly qualified teachers. This is not surprising, since interest in the subject was at low ebb for many years and there was little incentive for training teachers. The resulting vicious circle complicates a problem which at best is very difficult because of competition among numerous subjects in school curricula.

The three successive conferences in New England have met an encouraging response, and plans for next year's meeting are already taking form. The fourth conference will be held at the Salem State Teachers College, Salem, Mass., on March 21, 1953, under the chairmanship of Mary E. Mrose.

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Scientists in the News

Leading neurologists and neurosurgeons from the U. S., Canada, and Europe convened recently for a scientific program and a dinner in celebration of the 60th birthday of **Percival Bailey,** distinguished professor of neurology and neurological surgery at the University of Illinois College of Medicine, and director of the Illinois State Psychopathic Institute.

W. G. V. Balchin, of King's College, London, and **Norman Pye,** of the University of Manchester, have undertaken a study of desert landforms and erosional processes in the Mohave and Sonoran deserts of California and Arizona. The project is being supported by the universities of London and Manchester, the Royal Society, and the Royal Geographical Society, and with Fulbright funds.

George Barnhart, one of the first research chemists to be employed at Du Pont's Jackson Laboratory, has retired after 34 years of service. He joined the Jackson Laboratory staff in 1918 as a research chemist, and thus was in at the beginning of the pioneering development of an American dye industry which was started during the first world war.

Homer R. Bolen, professor of biology at Southeast Missouri State College, Cape Girardeau, has been appointed head of the Science Department. He succeeds **A. C. Magill,** who retired from active duties but remains associated with the college as professor emeritus of chemistry.

John Boyd-Orr, former director-general of the UN Food and Agriculture Organization, has succeeded **Guy Marshall** as chairman of Pest Control, Ltd., in the United Kingdom.

J. Chester Bradley is retiring from the Department of Entomology at Cornell University. One of the founders of the Entomological Society of America, he served as its first secretary-treasurer and was president last year. He is also one of three American members of the International Commission on Zoological Nomenclature.

Virginia M. Brigham, of Belmont, Mass., has been promoted to assistant professor of physics at Simmons College. She joined the Simmons staff in 1950.

Paul F. Clark, head of the Department of Medical Microbiology at the University of Wisconsin Medical School, is retiring from the faculty. He came to the university in 1914, after a period as bacteriologist for the Rhode Island State Board of Health, and work at Johns Hopkins Medical School and at the Rockefeller Institute for Medical Research in New York.

E. U. Condon, president-elect of the AAAS, has received an honorary D.Sc. degree from American University for his contributions to the theory of nuclear, atomic, and molecular structure. Dr. Condon was also cited for his contributions to national defense, particularly in the fields of nuclear and electronic physics, and was praised for his achievements in the administration of science in government, industry, and the universities.

Harold J. Coolidge, executive director of the Pacific Science Board of the National Academy of Sciences—National Research Council, and associate in mammalogy at the Harvard Museum of Comparative Zoology, has recently been appointed by royal decree a member of the Commission of the Institute of the National Parks of the Belgian Congo, which has the responsibility for the administration of the Congo parks.

The Remington Honor Medal, pharmacy's highest award, will be given to **Patrick Henry Costello,** secretary of the National Association of Boards of Pharmacy and secretary of the American Council on Pharmaceutical Education, at a dinner meeting of the New York Branch of the American Pharmaceutical Association, probably in December of this year. This award was established by the New York Branch of the A.Ph.A. in 1918, to be given annually to the individual who has done most for American pharmacy in the previous year, or whose continuing contributions to the advancement of the profession have been outstanding. The past presidents of the American Pharmaceutical Association serve as the jury of award. In citing reasons for the selection of Mr. Costello, the jury called attention to his outstanding service in the development of the program of reciprocal licensure for pharmacists and his contributions to the program of accreditation of colleges of pharmacy.

Richards W. Cotton has been given a temporary leave of absence from Phileo Corporation to accept appointment as chairman of the Electronics Production Board of the Defense Production Administration and director of the Electronics Division of the National Production Authority, Department of Commerce. Mr. Cotton, who has been assistant to the president, will serve in his new post until Dec. 31, giving civilian direction to phases of the mobilization program affecting electronics equipment.

Louis de Broglie has been awarded the Kalinga prize by Unesco. **B. Patnaik,** Indian industrialist, established the award last year. The French Nobel Prize winner and permanent secretary of the Section of Mathematical Sciences of the French Academy of Science received one million francs (equivalent to £1000, or $2800) as first winner of the annual prize awarded by Unesco for outstanding achievement in the interpretation and popularization of science. The jury for the award was composed of Göran Liljestrand, of the Caroline Institute, Stockholm; M. N. Saha, professor of physics at the University of Calcutta; and Paul Gaultier, member of the Institut de France. They represented the biological and the physical sciences, and the reading public, respectively.

Kalinga was an empire that covered part of India and Indonesia more than 2000 years ago.

Robert H. Dott, director of the Oklahoma Geological Survey, has accepted the new position of executive director of the American Association of Petroleum Geologists. The rapidly growing membership of the AAPG, now about 9000, has made necessary a larger headquarters staff. Mr. Dott will direct the various activities of association headquarters, but the preparation of new books and special volumes on problems and methods of petroleum geology will receive his particular attention. **John W. Clark,** assistant chief geologist of the Magnolia Petroleum Company, Dallas, has been appointed secretary-treasurer of the association to serve out the unexpired term of Mr. Dott, who is resigning to accept his new position.

At the 85th annual meeting of the American Otological Society in Toronto, **Edmund P. Fowler,** of New York, was awarded a certificate of merit and bronze medal for his research in otosclerosis and his pioneer work in otology. He was also the recipient of the $1000 prize of the society.

Ernest Gamble, Jr., has been named assistant director of the National Printing Ink Research Institute at Lehigh University. Mr. Gamble has been a graduate assistant with the institute since its inception in 1946.

Irving R. Glass, executive vice president of the Tanners Council of America, has received the annual Medal of Merit of the National Hide Association for his contributions to the development and growth of the tanning and hide industries. Mr. Glass has headed the Tanners Council, national trade association of leather manufacturers, since 1947.

Palmer W. Griffith, of American Cyanamid Company, received the eleventh annual John Wesley Hyatt Award, sponsored by the Hercules Powder Company, "for achievement of wide importance to the plastics industry." Mr. Griffith was cited for his researches with melamine, bringing this material from a laboratory curiosity to a plastic that has become the basis of a new industry.

Frank L. Gunderson, scientific research and technical development vice president, is leaving his position with Pillsbury Mills, Inc., and **Walter T. Blake,** who was recalled to active duty as lieutenant colonel in the Army, has returned to the company from White Sands Proving Ground. He will be assigned the position of manager of the Research and Development Department.

H. Rupert Hanmer, director of research, American Tobacco Company Research Laboratory, Richmond, and **Vada C. Miller,** science teacher, Dayton High School, were honored recently by the Virginia Section of the American Chemical Society. Each received Distinguished Service Awards—Mr. Hanmer for his many contributions to the advancement of chemistry in the state and Miss Miller for her inspirational influence in the teaching of science to high school students.

Delbert F. Jurgensen, Jr., has been appointed to a new executive post as director of engineering and development at Congoleum-Nairn, Inc. Dr. Jurgensen formerly was director of chemical research and development of the American Machine and Foundry Company and chief engineer of its Engineering Division, Special Projects Department, which designed new special-purpose machines and equipment for the Atomic Energy Commission's Savannah River installation.

John W. Knutson has been named chief dental officer of the U. S. Public Health Service. Dr. Knutson, chief of the Division of Dental Public Health, succeeds **Bruce D. Forsyth,** who has concluded a four-year tour of duty and is taking over new duties with the Federal Security Agency Region I in Boston. Dr. Knutson joined the Public Health Service in 1931 and has been a member of the Commissioned Corps since 1934.

Oscar Lewis, associate professor in the Department of Sociology and Anthropology, University of Illinois, will leave in August for India, where he will join the staff of **Douglas Ensminger,** who is in charge of the Ford Foundation program in India and Pakistan. Dr. Lewis will be on a two-year leave of absence, working on a joint government and Ford Foundation project, in which Indian personnel will be trained in modern extension service methods in special centers set up in 15 provinces.

Seymour Lieberman, assistant professor of biological chemistry at Columbia University and a member of the staff of Memorial Hospital, New York, in recognition of his work in identifying the steroid compounds isolated from urine, was presented with the Ciba Award for 1952 at the 34th annual dinner of the Endocrine Society. The award is presented each year by Ciba Pharmaceutical Products, Inc., to a society member not more than 35 years old for outstanding work in the field of clinical or preclinical endocrinology.

Walter H. Mais has been elected chairman of the Brooklyn College Department of Physics to succeed **Morris Francis Weinrich,** who retired at the end of the present semester. Professor Mais heads a Brooklyn civilian defense training unit for radioactivity detection. He is chairman of the college's Long Term Curriculum Study Committee.

David F. Marsh, professor and head of pharmacology at the School of Medicine of West Virginia University, is joining the Transandino Company, Palo Alto, Calif. (R. C. Gill Laboratory for Curare Research), as executive vice president and codirector.

Mancel T. Munn, head of the Division of Seed Investigations, New York State Agricultural Experi-

ment Station, Geneva, will retire Aug. 1, following 40 years of service. He served as U. S. delegate to the last six International Seed Congresses and since 1939 has held the post of editor of the *Proceedings* of the Association of Official Seed Analysts. **Benjamin E. Clark** will succeed Dr. Munn.

Alf Nyberg has been appointed visiting professor of meteorology at Florida State University for the coming academic year. Dr. Nyberg will be on leave as chief, Aerology Section, Swedish Meteorological and Hydrological Institute, and from the faculty of the University of Stockholm.

Edwin P. Swatek, chief design engineer of the contracting division of Dravo Corp., Pittsburgh, has received the Fuertes Graduate Medal of the School of Civil Engineering at Cornell University, for a paper dealing with construction of Lock 2 on the Monongahela River, a project on which he was chief designer. The medal was established in 1893 by Estevan A. Fuertes, first head of the school. It is awarded annually by the faculty to a graduate of the school for a meritorious paper tending to advance the scientific or practical interests of the civil engineering profession.

John V. Taggart, of the College of Physicians and Surgeons, Columbia University, has been awarded the Edward N. Gibbs Memorial Prize of $2000 for researches on the etiology, pathology, physiology, or treatment of diseases of the kidney and for studies on renal physiology and tubular transport mechanisms. The prize was initiated in 1901 by Mrs. Edward N. Gibbs and Mrs. George Gibbs Sherrill in memory of Edward N. Gibbs, and is awarded at irregular intervals under the auspices of the New York Academy of Medicine.

A. C. Trowbridge, vice president of the AAAS and chairman of the Section on Geology and Geography (E), is retiring as professor and head of the Department of Geology at the State University of Iowa, and **A. K. Miller** will become head of this department. Dr. Trowbridge has been a member of the departmental staff since 1911 and head since 1934. Dr. Miller joined the staff in 1931.

Ernest H. Volwiler, president of Abbott Laboratories, has been elected a director of the American Chemical Society to fill the unexpired term of **Farrington Daniels,** of the University of Wisconsin. Dr. Daniels became an ex officio member of the board of directors when he was named president-elect of the society. Dr. Volwiler was president of the society in 1950.

Visitors from abroad who recently visited the National Bureau of Standards include **E. Wigelius,** State Institute for Technical Research, Helsinki; **Joseph Frenkiel,** Research Council of Israel; **E. Kambara,** Tokyo Institute of Technology; **E. T. Goodwin,** Mathematics Division, National Physical Laboratory, England; and **C. W. Jones,** Department of Applied Mathematics, University of Liverpool.

Education

Mortimer J. Adler has resigned his chair of the philosophy of law at the University of Chicago to go to San Francisco to direct the founding of an institute for philosophical research. He will remain a member of the board of the Great Books Foundation, which he was largely instrumental in establishing. The new institute will be started with grants of more than half a million dollars from the Fund for the Advancement of Education and the Old Dominion Foundation. The latter was the chief source of funds for the institute's predecessor at Chicago. Main purpose of the new organization will be to promote the advancement of learning through analysis of basic ideas and issues in Western thought.

The **Army Medical Service** will conduct 17 short postgraduate courses in surgery, psychiatry, and allied subjects during the last six months of 1952. The instruction is open to both military and civilian physicians and will be conducted at Army and Navy Hospital, Hot Springs, Ark., at Letterman, Walter Reed, Fitzsimons, and Brooke Army Hospitals, and at the Armed Forces Institute of Pathology in Washington, D. C. Civilian physicians should apply to the appropriate hospital or installation commander.

HMS *Challenger* is on a world cruise from England to do isolated survey jobs and to carry on the work started by her nineteenth-century predecessor. The new *Challenger* has modern echo-sounding gear, bottom samplers, and the deep-ocean type of seismic refraction and reflection apparatus developed by Hill and Swallow. The ship left the Pacific area in April, bound for the United Kingdom via the Indian Ocean and the Mediterranean. The world's deepest sounding (5940 fathoms) was obtained in the trench between Guam and Yap. T. H. Gaskill is geophysicist for the expedition.

George W. Kisker, associate professor of psychology at the **University of Cincinnati,** is engaged in making tape recordings of lectures and discussions by psychologists and psychiatrists in universities throughout the country. The recordings are filed in a library until requested by another college or university. Rerecordings are then made on tape, standard 78 rpm phonograph records, or on long-playing records, as required. Recordings are now being prepared by professors at various U. S. universities, and negotiations are under way for the recording of lectures at universities throughout the world. It is planned to add other areas of learning to the library.

The **Cooperative Bureau for Teachers,** New York City, has appointed Sidney J. French, Colgate University, chairman of its Governing Board for 1952–54. J. Folwell Scull, Jr., of Polytechnic Preparatory C.D.S., has been appointed vice chairman, and William S. Willis, of the Unesco Fellowship Division, director of the College Department. Under Dr. Willis' guidance the department will continue its work of building up a central national placement

service for college teachers. Louis T. Benezet, president of Allegheny College, is chairman of the College Committee.

The **Fund for the Advancement of Education** has appropriated $300,000 to establish a new program to assist liberal arts colleges in a critical examination and appraisal of their work. A committee of college presidents and deans has been appointed to review the applications and to select 10–15 institutions to which grants will be made. All liberal arts colleges are eligible to participate. Applications must be received not later than *Nov. 1*, and awards will be announced about *Dec. 15*.

The **University of Pittsburgh** graduate School of Public Health has appointed the following assistant professors: Sidney Cobb (biostatistics and epidemiology), James S. Dinning (biochemistry and nutrition), Mildred Mouw (public health nursing). Elizabeth R. Kramm has been appointed research associate in maternal and child health.

Grants and Fellowships

The **National Multiple Sclerosis Society** has made a grant to the Indiana University School of Medicine for an investigation of the cellular responses that occur in the central nervous system of mice and rats as a result of the JRM virus. Chief investigator will be Orville T. Bailey, professor of neuropathology. A second study will be made at Boston University School of Medicine to determine the amino acid patterns of the spinal fluids in multiple sclerosis and other neurological diseases. Burnham S. Walker, professor of biochemistry, will direct the work.

The **National Research Council** has announced awards for 1952–53 under the four programs of fellowships that it administers. National Research Fellowships in the Natural Sciences, postdoctoral fellowships supported by the Rockefeller Foundation to promote fundamental research, were awarded to 13 scientists: George Richmond Bird, Columbia; Julian Calvert Eisenstein, Clarendon Laboratory, Oxford; Isidore Bernard Fleischer, University of Nancy; John Bernard Hanson, Caltech; Donald Gordon Higman, McGill; Martin Jesse Klein, Dublin Institute for Advanced Studies; Dan Leslie Lindsley, Jr., Princeton; Ariel Gideon Loewy, University of Cambridge; Edward Allen Mason, University of Wisconsin; Robert Gail Mills, Princeton; Norbert Muller, University of Chicago; John Essington Sanders, U. S. National Museum; William George Van der Kloot, University of Cambridge.

Eight awards of Merck Postdoctoral Fellowships in chemical and biological research were made: Joseph Jacob Blum, Caltech; Donald Hartwell Bucklin, Harvard; Richard Leslie Hinman, University of Cambridge; Edward Lowell Hokin, Montreal General Hospital Research Institute; Robert Guy Parrish, Cambridge University; and renewal awards were made to Lawrence Bogorad, Rockefeller Institute for Medical Research; Andre Tridon Jagendorf and Philip Standish Thayer, University of California.

Five awards were made under a new fellowship program, the Lilly Research Laboratories Postdoctoral Fellowships in the Natural Sciences: John Harold Barrett, MIT; Albert William Burgstahler, Harvard; David Powell Hackett, University of London; David Swenson Hogness, Institut Pasteur; Michael Mullen Robison, University of Cambridge.

The RCA Predoctoral Fellowships in Electronics, supported by the Radio Corporation of America, to give special graduate training in electronics were awarded to Harry Dreicer, MIT; and William Richard Grow, Stanford; and renewal awards were made to Casper W. Barnes, University of Florida; Bernard E. Keiser, Washington University; and Seymour Stein, Harvard.

The **Sarah Mellon Scaife Foundation** is continuing the Multiple Fellowship on Orthopedic Appliances at the Mellon Institute for the sixth year. A special Medical Advisory Committee to guide the work has been set up under the chairmanship of E. R. Weidlein. Serving with him are William S. McEllroy, Paul B. Steele, John A. Heberling, and Carl C. Yount. Dr. Yount has become an Advisory Fellow of the Institute, to work closely with the staff of the fellowship. Donald A. Covalt, of New York City, and Augustus Thorndike, of Boston, have recently been added to the committee.

The **John Hay Whitney Foundation** has awarded "opportunity fellowships," totaling $100,000, to 50 young men and women of minority groups from Guam, Hawaii, Alaska, the Virgin Islands, Puerto Rico, the District of Columbia, and 20 states. The awards are made annually to American citizens who, "because of arbitrary barriers such as race, cultural background or region of residence, have not had the fullest opportunity to develop their abilities."

Meetings and Elections

The **American Education Fellowship** has elected H. Gordon Hullfish, professor of education at Ohio State University, president to succeed Kenneth Benne, of the University of Illinois. He will serve for a three-year term, and during that period headquarters of the organization will be on the Columbus campus.

The **American Phytopathological Society** is sponsoring a symposium on plant-parasitic nematodes and their control at the next annual meeting to be held Sept. 8–10 at Cornell University. A panel of nematologists, consisting of J. R. Christie, G. Steiner, A. L. Taylor, and G. Thorne (USDA), D. J. Raski (University of California), and C. W. McBeth (Shell Oil Company), will present papers dealing with the basic aspects of nematology and chemical control of nematodes.

The **Billings** (Mont.) **Geological Society** will hold its annual field conference Sept. 4–7, under the general chairmanship of George Darrow, in the Black

Hills and Williston Basin area. Headquarters will be at Deadwood, S. D. Emphasis will be on the Paleozoic rocks. All those who wish to attend should write immediately to John M. Parker, Box 797, Billings, to obtain registration blanks.

The seventh annual meeting of the **Calorimetry Conference** will be held at the National Bureau of Standards, Washington, D. C., Sept. 20. For further information, write to the program chairman, Guy Waddington, U. S. Bureau of Mines, Bartlesville, Okla.

The fourth **International Congress of Hematology** will be held in Mar del Plata, Argentina, Sept. 21–28. Six scientific sessions, a symposium on hemophilia, and round-table discussions will be held. Among U. S. scientists listed on the provisional program are W. H. Seegers, J. B. Graham, William Dameshek, J. S. Lawrence, Jacob Furth, J. H. Burchenal, E. P. Cronkite, George Brecher, Leo Jacobson, Egon Lorenz, O. P. Jones, and Ernest Witebsky. For further information, address Sol Haberman, secretary-general, 3301 Junius St., Dallas, Texas.

The **Metal Powder Association,** meeting last April in Chicago, elected Ernest H. Klein president to succeed Thomas L. Robinson, who was elected chairman of the Board of Directors. Thomas Moore was elected vice president, and George Roberts was elected to the Board.

The **New Orleans Academy of Sciences,** at its annual meeting in May, elected Walter Moore president, Hyman Mayerson vice president, Karlem Riess secretary, Carl M. Conrad treasurer, and Garland Taylor curator. In addition to the meeting of the senior academy, there was an exhibit and a series of talks by members of the Junior Academy under the sponsorship of George C. Daul, of Southern Regional Laboratory. The New Orleans Academy is discussing plans for the celebration of its centennial in 1953 and has made changes in its bylaws to permit closer cooperation with industry.

The annual **Plant Science Seminar** will be held Aug. 12–16 in Philadelphia, just preceding the meeting of the American Pharmaceutical Association. All persons engaged in any phase of plant science are invited to attend. Frank H. Eby, of Temple University School of Pharmacy, is head of the local committee.

A Boston University chapter of **Sigma Xi,** with a total enrollment of 93, was installed on Apr. 5. The officers are Chester M. Alter, president; Arthur M. Lassek, vice president; and Henry D. Russell, secretary-treasurer. Shields Warren spoke at the installation dinner, on "The University and Science: Commensal or Parasitic?"

A symposium on **The Utilization of the Major Metabolic Fuels** will be held Sept. 3–5 by the Department of Biology, Brookhaven National Laboratory. Speakers will be S. Soskin, A. Wick, D. D. Feller, S. S. Chernick, R. Levine, DeW. Stetten, P. Handler, M. Stetten, F. Dickens, R. O. Brady, S. Gurin, W. Sakami, S. Korkes, and S. Weinhouse. Robert Steele, J. Raymond Klein, and Martin Gibbs comprise the Symposium Committee.

Miscellaneous

Claremont College has announced the affiliation of **Rancho Santa Ana Botanic Garden** under the Claremont group plan of the Associated Colleges. By arrangement between Pomona College and the Garden, part of the college's botanical library and the college herbarium have been combined with the Garden's library and herbarium. Richard K. Benjamin has been appointed Garden mycologist and assistant professor of botany in the Claremont Graduate School. The Garden will be open to the public in 1953.

Deep-sea investigations, using a bathysphere, are being undertaken in Japan this year. The Japanese newspaper *Yomiuri Shimbun* contributed one third of the construction funds, the remainder being given by other organizations. U. Nakaya is chairman of the committee appointed for the administration and future utilization of the bathysphere, and Koji Hidaka, chairman of the Pacific Science Association subcommittee on Physical Oceanography, and Pacific Science Council member from Japan, is also a member. N. Inouye, who then obtained funds for the construction of the bathysphere, plans to make the first descent.

Headquarters Technical Information Service of the **Department of Scientific & Industrial Research** has been merged with the Technical Information and Documents Unit. The new unit, which retains the name TIDU, holds the German industrial documents which were taken to England after the war. It is receiving unpublished reports from British and American sources and is the British center for an international questions-and-answers scheme, to provide information about industrial techniques from the U. S., Canada, France, Germany, Ireland, Sweden, and the U. K.

Pakistan's first seismological research station, now being built with Unesco's technical assistance, completely lacks back numbers of scientific journals. The new service would be grateful for spare reprints of seismological papers published before 1948. Copies should be sent to Pakistan Meteorological Service, Geophysical Division, Kings Road, Quetta, Pakistan.

Chemicals wanted by the **Registry of Rare Chemicals,** 35 W. 33rd St., Chicago, Ill., include: Titanium sulfide; aluminum triethyl; sodium dithioformate; selenourea; DL-1-aminocyclohexanecarboxylic acid; 4-aminopterine; sym-diisopropyl hydrazine; 1,12-dodecanedioic acid; lignoceryl alcohol; mellitic acid; *n*-tridecyl amine; 5,9,10-benzanthracene; 1,12-benzperylene; ursolic acid; novirudim; nicotyrine; lanthionine; putrescine; tyrosol; and coronene.

Technical Papers

Electron Microscopy of Chromosomes in Smears[1]

Israel J. Heilweil, Harriet G. Heilweil, and Quentin Van Winkle[2]

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In a previous communication from this laboratory, Van Winkle *et al.* (*1*) reported the results of electron microscopical studies on isolated resting chromosomes. Concurrently, techniques were developed for the electron microscope investigation of the giant salivary gland chromosomes of *Drosophila melanogaster* and the meiotic chromosomes of the microsporocytes of *Rhoeo discolor* in smear preparations.

Electron microscope studies of plant chromosomes isolated by a microdissection method have been reported by Buchholz (*2*). Drosophila giant chromosomes have been examined electron microscopically in smears by a negative replica method (*3*) and by the smear transfer method of Schultz *et al.* (*4*).

In order to investigate chromosomes in smears that have been chemically treated so as to reveal details of chromosomal structure and composition, a simple and easily mastered technique for transferring entire smears from glass slides to electron microscope specimen-supporting screens was adapted from a procedure described by Manton and Smiles (*5*). Drosophila salivary glands were dissected out in 45% acetic acid, fixed in this reagent for 10 min, and smeared in the usual manner. Anthers of Rhoeo were first smeared on carefully cleaned slides with a flat-honed knife, fixed in 45% acetic acid for 10 min, and then flattened. Cover glasses were removed according to a method described by Schultz *et al.* (*4*), which involves freezing the slides on dry ice for about 10 min and prying up the cover glasses with a chilled razor blade. Subsequently, the slides bearing the smears were placed in a slide carrier and passed through a given series of reagents.

If the smears were to be transferred to electron microscope screens immediately after fixation, the slides were passed successively, for 15-min periods, into solutions of glacial acetic acid and absolute ethanol in the proportions 1:1, 1:3, 1:9, and 0:1. They were then washed in amyl acetate and dried in a vacuum desiccator. Each individual slide was next dipped vertically into a 1:4 solution of collodion and amyl acetate, removed slowly and steadily, drained of excess solution by touching the end of the slide to absorbent paper, quickly placed in a vacuum desiccator in a vertical position, and dried for 30 min at room temperature. The following day, small rectangles of film were stripped from the slide by an adaptation of a method devised by Martin and Tomlin (*6*). After a suitable area of the smear was located by means of the phase microscope, three sides of a rectangle approximately 3×5 mm, and surrounding the selected area, were cut with a sharp, single-edged blade. The slide was then held in a dish of water at a 45° angle so that the rectangle was completely immersed, its uncut narrow edge uppermost. Under a dissecting microscope the lower cut edge of the rectangle was teased up, and the flap was pulled gently with carefully ground square-ended forceps. When the rectangle was free of the slide except at its uncut edge, the slide was removed from the water in such a way that the rectangle returned to its original position. The fourth side was then cut through, and the slide immersed vertically into a dish of water so that the rectangle of film floated off onto the surface of the water. The freed rectangle was picked up on an electron microscope specimen screen by bringing the screen up under it. After touching the edge of the screen to filter paper, the specimen was dried over phosphorus pentoxide overnight.

Some smears, fixed in acetic acid, with cover glasses removed, were subjected to a procedure devised by Bretschneider (*7*) and described by Van Winkle *et al.* (*1*), which is believed to localize desoxyribonucleic acid in electron micrographs. They were subsequently dehydrated by carrying the slides through water-ethanol solutions of increasing ethanol concentration. They were then embedded in collodion film, stripped, and mounted on electron microscope screens as outlined above. In other experiments, acetic acid–fixed smears were dehydrated in the glacial acetic acid–absolute ethanol sequence followed by two additional changes of absolute ethanol, dried in air, and digested for 1 hr in a solution of desoxyribonuclease at 40° C according to the procedure of Palay and Claude (*3*). The enzyme solution was prepared by dissolving 0.01 mg of the enzyme per ml of phosphate buffer of pH 7.3 made 0.005 *M* in $MgSO_4$. Following digestion, the slides were washed in five changes of water and three changes of absolute ethanol. They were dipped, finally, in the collodion film-forming solution, and the film was stripped and mounted as before.

All electron micrographs were made by means of an RCA Model EMU instrument.

The condensed stages of the meiotic chromosomes of Rhoeo were generally opaque even after conventional pretreatments, hydrolysis in 1.0 *N* HCl for 6 min, or the Bretschneider procedure. Structural details that would be beyond the limits of resolution of light microscopes, however, were observed in well-smeared chromosomes in late second telophase and

[1] These studies were aided by grants from the National Institutes of Health of the Public Health Service, E. I. du Pont de Nemours & Company, Abbott Laboratories, and the Chemistry Department of The Ohio State University.

[2] The authors wish to express their gratitude to Albert F. Prebus, Elton F. Paddock, and Allen S. Fox for their valuable assistance.

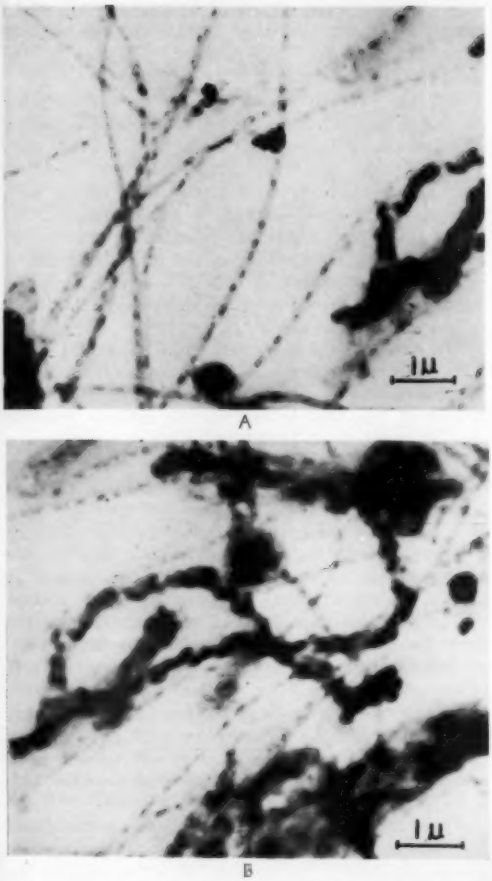

FIG. 1. Smear of microsporocyte of *Rhoeo discolor* in late second telophase fixed in 45% acetic acid.

early prophase stages. Electron micrographs of late second telophase chromosomes fixed only in acetic acid (Fig. 1) indicate that these chromosomes are made up of undetermined numbers of tubules, about 0.1 μ in diameter, twisted about each other, often in pairs, and having distributed within them dark segments approximately 100 × 50 mμ in cross-sectional area. It appears that the twisted tubules are enclosed in a casing. The apparent spiraled structure of chromosomes, as at the lower right of Fig. 1 *A*, may be due to the arrangement of the dark segments of the twisted tubules. Identical structures were seen in electron micrographs of late second telophase chromosomes treated according to the Bretschneider procedure. The diameters of the tubules agree in order of magnitude with those of the tubules observed by Van Winkle *et al.* (*1*) in suspensions of isolated animal chromosomes which had undergone the Bretschneider treatment. In their general appearance, the tubules closely resemble the chromatin strands isolated by Claude and photographed in the light microscope (*8*).

When salivary gland smears of Drosophila were fixed only in acetic acid and then transferred by the procedure described above and examined in the electron microscope, bands ordinarily observed in the light microscope were seen to be composed of several narrower bands. In addition, numerous fine bands were discerned in the so-called interband regions. Fig. 2

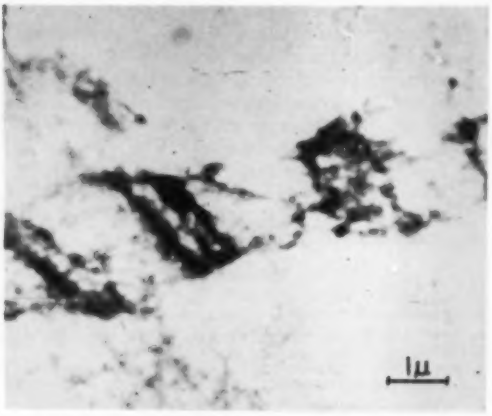

FIG. 2. Salivary gland chromosome of *Drosophila melanogaster* treated according to the Bretschneider procedure.

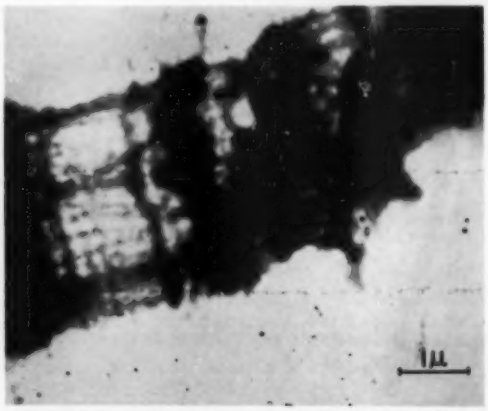

FIG. 3. Drosophila salivary gland chromosome treated with desoxyribonuclease.

shows a portion of a salivary gland chromosome subjected to the Bretschneider procedure. Apparently this treatment removes a considerable amount of material from both the band and interband regions and reveals the finest bands to be transverse rows of granules roughly 30 mμ in diameter. Moreover, fibers appear to connect the rows of dark granules in an irregular fashion. Similar details are seen in the desoxyribonuclease-digested chromosome of Fig. 3, but the trans-

verse rows of granules and the generally longitudinal connecting fibers are more regularly arranged. Smears of silver-stained (*1, 7*) salivary gland chromosomes were also examined in a microscope using visible light. It was found that the band regions were strongly stained by silver, whereas the interband regions were either slightly stained or not stained at all. The total lengths of the chromosome arms were not appreciably altered by the silver-staining procedure, but the widths of the arms were considerably reduced. The nucleolus was observed to be stained slightly by silver.

From the results obtained thus far, it is evident that the technique of transferring smears to electron microscope screens by embedding them in collodion films is applicable to smears treated chemically by a wide variety of methods so as to disclose details of the internal structure of chromosomes. The technique has the further advantage that in itself it involves only a few easily performed steps and a minimum number of reagents. Further electron microscope studies of chemically treated chromosome smears are in progress.

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Fatal *Trypanosoma cruzi* Infection in the White Rat[1]

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This is a preliminary report on the laboratory infection of white rats with *Trypanosoma cruzi*, running an acute course and terminating in the death of the animal.

Many animals, such as rats, mice, lemurs, guinea pigs, monkeys, dogs, and cats, may be experimentally infected with *T. cruzi*. Mice and guinea pigs are especially useful in diagnostic and research work on Chagas' disease (*1*). Inoculations of white rats with citrated blood from the patients have been successful in some cases. The guinea pig is less useful because it is less susceptible to infection than the white rat (*2*). Baby rats inoculated intraperitoneally with large doses of *T. cruzi* cultures show a few trypanosomes in the blood after an incubation period of 10 days to 2 weeks. This mild transient parasitemia, lasting about 2 weeks, was associated with leishmania forms in the cardiac muscle and in the reticuloendothelial cells, and ended in the complete recovery of the animal (*3*).

For the past 10 years, we have been attempting to find a method of inducing acute fatal infection in a laboratory animal with cultures of *T. cruzi*. Different animals and various methods were tried. A mild and transient invasion of the blood stream with trypanosomes was observed in most animals. One method was to inoculate *T. cruzi* cultures into animals following the blocking of the reticuloendothelial system with India ink or colloidal metals. Transient parasitemia with mild infection was induced, but most of the animals recovered (*4*).

Week-old, hybrid baby rats which were still being nursed by the mother were used routinely in our experiments. The skin was thin, tender, and completely devoid of fur. One to two million actively growing trypanosomes in 7–10-day-old cultures of *T. cruzi* from bi-phasic Seneca hemoflagellate medium were injected intraperitoneally in 0.2 ml saline with a 24-gauge needle. Since the abdominal wall was very thin, there was leakage of the injected culture through the hole made by the needle. To obviate this, the site of the inoculation was rubbed with cotton dipped in alcohol. Concomitantly, 6.25 mg cortisone acetate (Merck, 0.25 ml) was injected subcutaneously in the back. Twenty-four hr later, a second dose of 6.25 mg cortisone acetate was injected. There were two sets of controls for each litter. One set was injected with two doses of cortisone, and the second with *T. cruzi* intraperitoneally. All the baby rats were put together, and nursed by the mother rat. Both wet blood smears, and smears stained with Wright's stain were frequently examined.

About a week after the inoculation, an occasional trypanosome was seen in the cortisone-trypanosome group. Gradually the number of trypanosomes increased, so that in 3–4 weeks, there were 25–100 trypanosomes per high-power field of the microscope. Some of the animals died of severe parasitemia in 3 weeks after inoculation. Inhibition or retardation of growth, loss of appetite, loss of weight, tendency to sluggishness, rough texture of the fur, eye infections, and gradually increasing paralysis of the hind legs were observed. Within 5 weeks all the inoculated animals died of muscular paralysis, which gradually spread to the muscles of respiration. Rats inoculated with trypanosomes only (controls) showed a mild transient parasitemia about 2 weeks after injection; the parasitemia lasted 10 days to 2 weeks, and terminated in complete recovery. Cortisone controls showed inhibition and retardation of growth, poor texture of fur, and reduced resistance to bacterial infection, but continued to live.

Post-mortem examination of the cortisone-trypanosome group showed congestion of the meninges, brain, and liver. The spleen was enlarged, and the heart dilated. No gross pathological changes were observed in the other organs. Sections of the tissues showed

[1] This study was supported by a grant from Chas. Pfizer & Co., Brooklyn, N. Y.

marked parasitic invasion of the cardiac muscle cells, and the brain cells (nerve and glia). The bone marrow and the liver were moderately heavily parasitized, and the spleen and the lungs had mild invasion. The kidney and the striated muscle were not invaded.

The second and third passages of the trypanosomes from the infected baby rats to healthy baby rats, which were also given cortisone, resulted in an increase in the virulence of the trypanosomes, so that the height of parasitemia was reached in about 10–15 days, and the animal died in 2–3 weeks. Cortisone and trypanosome controls were also included in these experiments. The former showed retardation or inhibition of growth. Trypanosome controls showed a mild transient parasitemia with complete recovery.

Further studies are in progress with other laboratory animals, and different strains of trypanosomes and leishmania. A complete report will be published at a later date.

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The Action of Some Water-Soluble Poly-α-Amino Acids on Fibrinolysis

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During our study of the action of water-soluble poly-α-amino acids on blood clotting (*1*), it was observed that the basic poly-amino acids: poly-lysine (*2*), poly-ornithine (*3*) and poly-arginine (*3*), retard fibrinolysis of human clotted blood. A more detailed analysis of this phenomenon was therefore undertaken.

Fibrinolytic activity of oxalated human plasma was induced by mixing the plasma with a suspension of β-hemolytic streptococci (*4, 5*), by treatment with a cell-free broth containing streptokinase (*6*), or by shaking the plasma with chloroform (*6, 7*). The activated plasma was then treated with the poly-amino acids (prepared in this laboratory), and a fibrin clot obtained by the addition of thrombin. The final mixtures were incubated at 37° C for 15–24 hr to determine if lysis occurred. When the preparations used did not interfere with fibrinolysis, dissolution of the clot occurred. Inhibition of fibrinolysis was indicated by the maintenance of the fibrin clot, obtained as described above, for 24 hr.

A typical experiment with poly-L-lysine and a streptococci-activated plasma is described below.

Oxalated human plasma (0.5 ml) was mixed with a suspension of β-hemolytic streptococci (0.4 ml), and the mixture added to 1 ml saline solution containing 40γ poly-L-lysine hydrochloride. Clotting was induced by adding 4 units of bovine thrombin (Upjohn Company) in 0.1 ml saline with vigorous shaking. The clot was incubated at 37° C for 24 hr. No visual change in the clot was observed. In the control experiment where the 1 ml poly-lysine solution was substituted by saline, a complete lysis of the clot was evident within 30 min.

The fibrinolytic activity of plasma activated by β-hemolytic streptococci was not inhibited either by the neutral poly-DL-alanine (*8*) or by the acidic poly-L-aspartic (*9*) and poly-D-glutamic (*10*) acids up to concentrations of 500γ/ml final test mixture. The basic poly-α-amino acids, poly-DL-lysine hydrochloride (average chain length $n = 35$) (*2*), poly-DL-ornithine hydrochloride ($n = 30$) (*3*), and poly-DL-arginine sulfate ($n = 30$) (*3*), on the other hand, prevented fibrinolysis at concentrations greater than 30γ–40γ/ml test mixture.

In the presence of the basic poly-amino acids, fibrinolysis was inhibited equally well when the streptococcal culture suspension was replaced (in the test mixture) by a cell-free supernatant containing streptokinase. Furthermore, it has been demonstrated that the fibrinolytic activity of chloroform-treated plasma and of menstrual blood was also inhibited by relatively low concentrations of poly-DL-lysine and poly-DL-arginine. It thus seems justified to assume that the basic poly-amino acids are capable of inhibiting hydrolysis of fibrin by plasma fibrinolysin (plasmin) under the experimental conditions used.

Preliminary experiments indicated that the average molecular weight of the basic poly-amino acids plays a profound role in the determination of their antifibrinolytic properties. L-lysine monomer, as well as L-lysyl-L-lysine (*11*), did not show any antifibrinolytic activity up to a concentration of 750γ/ml. A tetra-L-lysine showed slight antifibrinolytic activity at 750γ/ml, whereas poly-L-lysine of average chain length $n = 7$, 35, and 100 showed distinct antifibrinolytic activity at concentrations of 500γ, 40γ, and 35γ/ml test mixture, respectively.

No great difference was observed in the antifibrinolytic activity of poly-L-, poly-D-, and poly-DL-lysine of similar average molecular weights.

In our previous study on the action of water-soluble poly-amino acids on blood clotting (*1*), it was demonstrated that the acidic poly-amino acids, poly-D-glutamic acid and poly-L-aspartic acid, as well as heparin, are capable of neutralizing the anticoagulant activity of the basic poly-amino acids. A similar relationship was found to hold for the antifibrinolytic effect of the basic poly-amino acids. Heparin, as well as poly-L-aspartic acid ($n = 50$), was found to obviate the antifibrinolytic activity of poly-lysine. The neutralization of the antifibrinolytic activity of the basic poly-amino acids occurred when approximately equivalent concentrations of the basic and acidic poly-amino acids were applied.

The ability of the basic synthetic peptides to inhibit

reversibly the proteolytic activity of fibrinolysin resembles the antiproteolytic properties of some natural peptides, such as the pepsin inhibitor and the trypsin inhibitors (*12*). The interaction of the natural as well as the synthetic peptides with the different proteolytic enzymes is probably determined in both cases by some specific groups present in the enzyme and the inhibitor, as well as by the electrostatic forces prevailing between the enzyme and the relatively high molecular weight inhibitor. Further studies with the synthetic amino acid polymers may contribute to our basic knowledge of the mode of action of naturally occurring polypeptides on enzyme behavior.

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Action of Penicillin on Streptococci: Enhancement of Sensitivity *in vivo*?

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The bacteriostatic and bactericidal action of penicillin on growing bacterial cells may under certain conditions continue after the complete removal of the penicillin (*1*). On the other hand, it has been stated by Grunberg, Unger, and Eldridge that streptococci exposed to penicillin *in vivo* are temporarily more susceptible to the action of penicillin than are cells of the same culture not so exposed (*2, 3*). Because of the evident significance of this phenomenon, and because of the increasing use of the method of sensitivity testing upon which the conclusion was based, an attempt has been made to confirm the observation.

In brief, the experimental procedure used by Grunberg, Unger, and Eldridge was as follows. Mice were injected subcutaneously with a broth culture of a hemolytic streptococcus and were immediately treated by injection into the same site of sodium penicillin G. At intervals thereafter the mice were sacrificed, cultures were made of the tissues at the site of inoculation, and the sensitivity of the surviving organisms tested by the use of "gutter" plates. It was found that with advancing time the susceptibility to penicillin of the surviving streptococci progressively increased. The increase in sensitivity was deduced from the fact that with a constant concentration of penicillin in the gutter, the zone of inhibition, or distance from the edge of the gutter to the nearest streptococcal colony, became greater. It was stated, however, and examination of the protocols confirms it, that with time there was a marked decline in the number of streptococci in the lesion, and therefore in the number of streptococcal colonies on the test plate.

TABLE 1

EFFECT OF DENSITY OF INOCULATION ON DIAMETER OF "ZONE OF INHIBITION"

Expt. 1		Expt. 2	
Dilution of culture	Diameter of zone of inhibition (mm)	Dilution of culture	Diameter of zone of inhibition (mm)
Undiluted	32	Undiluted	42
10^{-1}	34	10^{-1}	40
10^{-2}	43	10^{-2}	44
10^{-3}	48	10^{-3}	62
10^{-4}	50	10^{-4}	76
10^{-5}	55		

In the present experiments the same strain of hemolytic streptococcus was used as was employed by Grunberg *et al.* It was used, however, without exposure to penicillin or injection into mice. Experiments were designed to test the effect of dilution of the culture on the apparent sensitivity of the organism to penicillin. Constant 0.1 ml portions of serial decimal solutions of an 18-hr broth culture were spread over the surface of a blood agar plate. A ceramic porcelain cup ("Penicylinder"®) was then fixed in place on the surface of the agar and filled with a solution containing 100 units penicillin/ml. After overnight incubation the diameter of the zone of inhibition which surrounded the penicillin cup was measured. The results are set forth in Table 1. It is evident that a very direct relation exists between the diameter of the zone of inhibition and the density of the inoculum.

These data indicate, therefore, that in order to explain the results which were seen following *in vivo* exposure of streptococcus to penicillin it is not necessary to invoke damaging effects associated with the *in vivo* situation. A simple decrease in number of streptococci present would serve equally well to explain them. The data also indicate the possible hazards associated with the use of the various disk and tablet methods for assaying the sensitivity of bacteria to various antibiotics in the clinical laboratory. Difficulties in interpretation of results would most easily arise when the disk method is applied to an initial mixed culture in which the absolute numbers and the proportions of various organisms are uncontrollable.

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The Detection of Crystals Following Local Injection of Cortisone and Compound F into the Skin of Man

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In the course of investigative studies (*1*) with the local application and injection of four oxysteroids, a cortisone acetate,[1] a water soluble ester[1] of cortisone, Compound F free alcohol, and Compound F acetate,[1] it was found necessary to attempt to control some of the observations by the examination of crystals of these compounds in the skin.

In routine paraffin-fixed sections crystals of these steroids cannot be found. The purpose of such studies on crystals is to determine the morphologic distribution patterns of such crystals in relationship to possible local mechanisms (epidermis, dermis, etc.) and the persistence in relationship to possible persistent local therapeutic effects from local injections. Moreover, an effort should be made to determine whether the crystals remaining in the skin are the same as those injected. Finally, a study of these crystalline masses may serve to explain the tissue reactions produced in normal tissue by the local injections of suspensions of cortisone and Compound F.

In his study of skin irritations in animals, Ake Nilzen (*2*) in our department, together with Knut Schmidt-Nielsen, was able to detect crystals presumably of cortisone acetate in the skin of guinea pigs following local injection. Their technique, in brief, was the preparation of frozen sections without fixation of tissue. We have modified the technique of Nilzen and Schmidt-Nielsen in our recent experiments with cortisone acetate and Compound F.

The steroids used in the work reported here included only cortisone acetate, Compound F, and cholesterol (plate type only). The vehicles used included, first, the suspension mixture of benzyl alcohol and polyoxyethylene sorbitan monooleate, sodium carboxymethylcellulose; and, second, saline as the only suspending agent. It was necessary to use saline suspensions since the other vehicle had definite reactions on local injection (*1*).

At first, suspensions of the steroids in the two vehicles were observed under varying conditions such as room temperature, freezing, and heating to attempt to determine any changes in the size of the crystals. At the suggestion of Schmidt-Nielsen, we incubated crystals of cortisone with minced human tissue (skin and subcutaneous tissue) at 37° for 24 and 48 hr. There was no change in the size of the crystals. The crystals of Compound F acetate measured in our experiments 1.25 μ and are smaller than those of cortisone acetate, which varied in length from 6 to 9 μ (Fig. 1). The crystals of the free alcohol of Compound F are 30–45 μ. The heavy saline suspensions of cortisone acetate gave larger crystals than the suspension of cortisone acetate in benzyl alcohol and the other suspending agents.

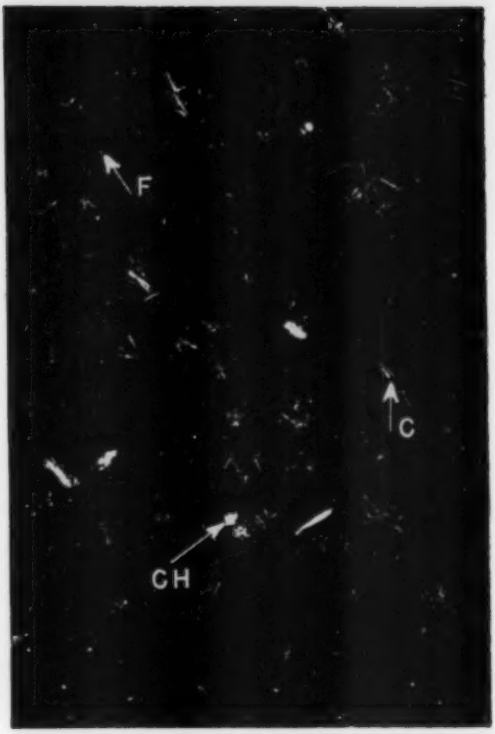

Fig. 1. Mixture of crystals of cortisone acetate (*C*), Compound F acetate (*F*), and cholesterol (*CH*). Vehicle, benzyl alcohol, polyoxyethylene sorbitan monooleate, and sodium carboxymethylcellulose; polarized light; approx × 100.

The following materials were injected intradermally into the normal skin of man: (1) vehicles without the steroid; (2) cortisone acetate suspensions, 25 mg/cc; (3) Compound F suspension, 25 mg/cc; (4) cholesterol, 25 mg/cc.

Injections of cortisone acetate and Compound F were done also with the Hypospray jet injection apparatus. Subsequently, injections of the steroids were made into pathologic skin and into normal skin which,

[1] Supplied by Augustus Gibson, Merck & Co., Inc., Rahway, N. J.

after the injection of the steroid, was subjected to various forms of local irritation. Biopsies were taken of skin from a few minutes to 4 months after injection.

Scalpel or punch biopsies were taken, in many instances without local anesthesia. The tissue was fixed in 10% neutral formaldehyde (calcium hydroxide) for varying intervals, then frozen sections were made. The following staining techniques were used: hematoxylin-eosin, oil blue N, Sudan III, Sudan IV, Schiff's periodic reagent, Giemsa, trichrome, van Gieson, and tetrazolium salts. The sections were mounted in glycerin jelly. A series of sections was also done with the vacuum freeze-drying technique, but no crystals were observed in the paraffin-imbedded sections. Experiments are now under way with other imbedding agents which are water-soluble. The sections were examined under ordinary light, polarized light, phase contrast, and ultraviolet light through a Wood's filter. For additional studies on the analysis of the local tissue reactions to locally injected steroids, routine paraffin tissue sections with a variety of staining techniques were also made.

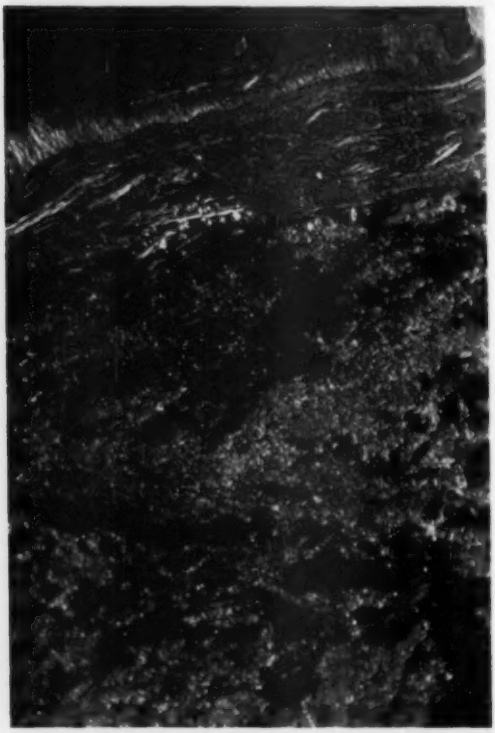

FIG. 2. Showing depth of crystal deposits of Compound F acetate in the skin of man 5 days after injection. Unstained section, approx × 100; polarized light.

After local injections, the insoluble crystals of cortisone acetate and Compound F are clearly visible in these unstained sections. The crystals are observed in large masses relatively deep in the skin even after superficial injections (Fig. 2). In superficial injections made with the Hypospray jet injection apparatus a broader band of crystal deposit was found. Experiments are under way at present to attempt to produce some intra-epidermal localization of crystals. In most instances the crystal size appeared to be the same as the size of an *in vitro* suspension. In some instances large birefringent crystals were observed from 5 min to 24 hr after the local injection of cortisone acetate. It is not entirely clear at present just what they represent. Except for this observation, it is apparent that there is no obvious change in these insoluble crystals as they persist in the skin. There is no proof, for example, that in the skin of man cortisone acetate can change into Compound F. Injections of the vehicle alone produced no crystals. With our present techniques, it was possible to identify crystals only when they occurred in large masses, not as individual crystals or portions of crystals. No fluorescence of crystals was observed under ultraviolet light.

For the staining techniques, Giemsa stains appeared to make the crystals more prominent by contrast staining of neighborhood tissue, both with cortisone and Compound F. Hematoxylin-eosin contrast staining was also effective. Experiments have been initiated recently with Frazer at the Environmental Health Center for electron microscopic examination of scrapings from the injection site after varying intervals of time. As additional controls of the local injection of crystals, chemical analyses of the local tissue for steroids are being done at the Merck Institute.

Following superficial injection, crystals of the steroid may persist in the skin for some months, especially when injected with the vehicle containing benzyl alcohol and polyoxyethylene sorbitan monooleate, sodium carboxymethylcellulose. Saline suspensions of the steroids do not persist as long. In pathologic skin, the crystals also do not persist as long.

Detection of crystals of steroids on local injection is a very important tool, especially with Compound F, since this steroid, unlike cortisone acetate in our investigations (*3, 4*), has a definite effect on various types of local inflammatory processes in the skin of man. One recent important phase has been the local effect of Compound F on lymphoma tissue. This is limited rather sharply to the area of injection. The study of frozen sections for crystals provides a definite help for the observations of the pattern of distribution of crystal masses. The superficial or deep deposit of crystals and the mass of crystals may influence the locus of the inhibitory reaction produced. There is a rough correlation between the degree of inhibition and the amount of Compound F present. The Hypospray jet injection apparatus provides for large masses of Compound F locally. It has not been possible, with our techniques, as indicated above, to determine whether these insoluble crystals change into

other compounds before solution. With the study of such crystal masses, it should be possible to determine the effects of various enzyme systems which may make for changes in the rate of solution. The persistence of the crystal deposits because of slow solution suggests that local therapeutic results may also persist for some time. This is borne out by our recent studies.

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Comments and Communications

Scientific Communication

JACQUES AVIAS' letter (SCIENCE, **115**, 250 [1952]) persuades me to state my own conviction that access to world literature is the next practical problem to be attacked in the art of scientific communication.

Nuclear Science Abstracts points the way. Every article published should be abstracted promptly at a central institute. Abstracts should be given serial numbers, each number unique. Authors and abstractors should list the words under which the article should be indexed, using single words for rare subjects, but using one or several modifying words for usual subjects. The ideal should be a bulky alphabetical subject index leading to the word (concept) desired, however deeply embedded, and without recourse to the title. The index of the *Encyclopaedia Britannica* is something on the order I have in mind, but it does not have enough modifiers on the index words to lead one directly enough to the few places where that word is used in the connection the researcher desires. The art of such indexing would have to be developed.

At present books are indexed by title, and there is no way of knowing from the indexing what the several chapters contain. It would be worth while to give each chapter an abstract, with its own unique number.

The power of such an index would be enormous. It would be attainable because the reference for every index heading would be only the bare abstract number, not the entire journal, volume, page, and year.

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The Teaching of Specific Dynamic Action

THE phenomenon of specific dynamic action seems to be a source of misunderstanding and perplexity to a great many students and to many teachers of biochemistry and physiology. I would like to suggest that the reason is the way the subject is usually presented by lecturers and in textbooks.

The student is likely to be told that the ingestion of protein equivalent to 100 kcal gives rise to 130 kcal. He may be told that carbohydrate and fat also have specific dynamic action, but in smaller degree. He will probably be told that, to allow for this, extra kilocalories must be added to the food intake that meets basal and activity requirements. An obvious way to think about these statements is that, if kilocalories are required to release those of the food, their release in turn must depend upon the expenditure of other kilocalories. How, then, can the effect ever be overcome? How can there be caloric equilibrium, or positive balance, or growth, and why do we not waste away because we eat? This seems to be a common complication of thought concerning specific dynamic action, and one can hardly believe that in such cases it is given credence.

Specific dynamic action as a topic merits only brief consideration in a general or elementary course, but the more briefly a subject is treated, the greater is the necessity of presenting the essentials clearly. This applies whether the course provides the student's only encounter with the subject, or whether it serves as preparation for more advanced study. The important thing in this particular case is that specific dynamic action has been demonstrated, and what it is and what it implies should be outlined. The following proposal provides a means of doing this without leading to perplexity. It depends upon stressing the relationship of specific dynamic action to the basal metabolism, which is more important than its relationship to the food.

When food is given to an animal under basal conditions, there is a subsequent period when the metabolic rate is higher, even though the same conditions are maintained. The length of this period and the degree of elevation above the basal depend principally upon the kind and quantity of the food. For any one food or food mixture the total increment is proportionate to the amount fed. Foods high in protein have the greatest effect. It follows that under such conditions, if the caloric value of the food given does not exceed the basal expenditure plus the increment, there will be negative caloric balance.

Quantitatively, the specific dynamic action is the energy increment to the basal which results from food utilization. The importance of the relationship of specific dynamic action to the basal metabolism must be realized for a proper understanding of the phenomenon. This is developed in the following example:

Suppose that an individual under basal conditions expends 60 kcal/hr. He is given food with a caloric

value of 200, as a result of which during the next 5 hr he expends not 300 but 320 kcal, at the end of which time the metabolic rate has returned to the basal level, and extra kilocalories equivalent to 10% of those provided have been expended. The basal expenditure of this individual is 1440 kcal/day. If just the basal requirements are supplied by this particular food, therefore, there will be an expenditure of 10% more, or 144 extra kcal; and even if the individual remains under the same conditions his total energy requirements will not be met. In this hypothetical case they will just be met, however, by 1600 kcal (1440 plus 10% of the ingested), and there will be positive caloric balance with anything over 1600—e.g., a surplus of 45 calories from 1650, of 810 kcal from 2500, etc.—which could be used to support activity over the basal. Such a presentation should be suitable and adequate to explain what specific dynamic action is without leading to any misunderstanding, and would occupy no more time than should be devoted to the subject in a general or elementary course.

At this stage, however, the student might be aided in evaluating specific dynamic action as a metabolic phenomenon by the following facts. Practically all our knowledge of specific dynamic action has been derived from studies of animals kept warm in the fasting state, but otherwise under basal conditions. Practically nothing is known about it in human beings under ordinary conditions of activity and everyday living, and under normal food consumption at the usual intervals. Ten per cent of the basal used to be regarded as the allowance to be made for specific dynamic action in human energy economy, but it probably should be smaller. The supposition that, because of its greater specific dynamic action, a high-protein diet is particularly beneficial in a cold environment has not received experimental support.

Our knowledge of the etiology and mechanism of specific dynamic action is at a stage where nothing more than brief reference should be made until students have gained considerable knowledge of intermediary metabolism.

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Transportation of Live Materials for Research

Many papers have been published regarding the value of live materials for instruction and research. Numerous specific reports of results of research projects, based on the ready availability of live animals, may be found in any scientific or medical periodical, In many instances the researcher may have had to collect the animals himself, spending his time and money transporting them home with his effects and equipment after solving the difficulties of collecting them in the field.

In other research programs, particularly in physiology, parasitology, pharmacology, and in innumerable projects directed toward public health, fresh, specific live materials are required on a series of delivery dates, as needed in the course of experiments, in the conduct of which the researcher has to have such facilities as pertinent literature, equipment, and qualified assistants to be sure of getting satisfactory results. Under these circumstances he must depend on the performance of a reliable supplier. For 12 years the writer has supplied specimens from the subtropical zone of Florida on a business basis, and many institutions have depended on his services.

Transportation handicaps beyond our control are critically interfering with our supply effort. Fast, dependable transportation is no longer available. Live materials are perishable. They are expected to arrive fresh and not *just* alive, for they may be used for weeks, or even months. We are confronted with embargoes of air express on shipments of live materials of any kind. They were put into effect first by a few airlines three years ago and are now applied by most American airlines with scheduled service, thus eliminating the most efficient and, all factors considered, the most economical way of shipping. Canadian airlines have no such embargo.

For all practical purposes there is an embargo on air parcel post, because of a ruling that admissible live materials should be so packed that they can be put into canvas mail sacks during transit, and this would result in suffocation. Small mammals are excluded from air parcel post. This service used to be excellent and economical. We used it for numerous shipments without any loss. A recent further restriction prohibits acceptance by first-class post offices of air parcel post in excess of 20 pounds. Acceptance up to 70 pounds is allowed by any second- or third-class post office. This rule forces us to take our shipments miles out of town to a second-class post office, which sends the packages back by rail to the first-class post office here in town, where acceptance was originally refused.

We have what practically amounts to an embargo of railway express service. When restrictions were placed on the competitive transportation services of air express and air parcel post, the Railway Express Co. priced itself out of the market for shipment of live materials, first by raising the basic rates, then by raising rate classifications and charging for live materials twice the first-class rate, by giving deficient service in transit, and finally by refusing claims.

It is difficult to see how this rate can be justified for any small-animal shipments, because they do not require extraordinary attention, such as feeding, watering, and cleaning of cages. As a matter of fact, these are not wanted. From 1939 to 1951 we rarely had any losses, although thousands of research animals were handled during this period. Our packages are clean, without any noticeable odor, and the animals are in uniform, patented, individual wire cages. The rates charged can only be considered penalties on animals shipped for research, because live tropical

fish for fish fanciers, baby chicks and chickens, frozen fresh fish, which require periodical icing and much attention, have continued to benefit from reduced, and even second-class, rates.

Business is seriously hurt by these unwarranted charges, since we often have to use Railway Express to get live materials from collecting stations on the long Florida Peninsula to the laboratory for processing, with the result that we incur the same high transportation charges twice. Commonly, the transportation costs are considerably in excess of the invoice value of the materials.

Our experiences with air freight were uneconomical and disastrous. In this service delivery dates could not be planned, because most of the flights are unscheduled and are completely suspended on Saturdays and Sundays, thus reducing the work week in collecting and in the laboratory to three days. Besides, a total air freight embargo on any live materials has eliminated Eastern Airlines, which operates the only route directly north, with connecting flights to the west. As a consequence air freight shipments are transported over a grand detour—e.g., from Tampa to Jacksonville to New York, to reach Chicago, and from Chicago by Railway Express to Champaign, Ill. The charges for this service are, of course, on a mileage basis. One shipment that we entrusted to the "fast service" by air freight took *7 days* to make this distance, and the animals arrived dead of dehydration and malnutrition. We replaced them by private plane and delivered the animals in Chicago within *6 hours*. Larger animals requiring feeding and watering have been shipped exclusively by Railway Express after this experience.

This account of transportation problems in the supply of live materials shows that immediate relief is a necessity.

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Book Reviews

Medicinal Chemistry: Chemistry, Biochemistry, Therapeutic and Pharmacological Action of Natural and Synthetic Drugs, Vol. II. Alfred Burger. New York–London: Interscience, 1951. 506 pp. $10.00.

The first volume of this two-volume text was reviewed in a previous issue (SCIENCE, **114**, 559 [1951]). In this second volume Burger has maintained the same admirable style and organization. Although there is an excellent chapter on the hormones, the book is chiefly concerned with the chemotherapy of diseases caused by pathogens. A chapter of especial merit is the one dealing with the theories of metabolite antagonism.

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The Barker Index of Crystals, Vol. I: ***Crystals of the Tetragonal, Hexagonal, Trigonal and Orthorhombic Systems,*** Part 1: Introduction and Tables; Part 2: Crystal Descriptions. M. W. Porter and R. C. Spiller. Cambridge, Eng.: Heffer, 1952. Part 1, 250 pp., 30s; Part 2, 1027 pp., £4 10s; £6 for both.

The first 120 pages of Part 1 of this giant reference book deal primarily with an introduction to the Barker Index. They give a highly condensed summary of elementary crystallography and of the important types of crystallographic projections—all from the standpoint of an amateur worker in such fields. This is followed by a short description of the Barker protractor and a short discussion of its five scales. This leads to a discussion of the multiple tangent table, followed by a worked-out "identification of an unknown crystal." Detailed consideration is given to symmetry determination, projection, setting and orientation, and the calculation of the classification angles, for the crystal systems: cubic, orthorhombic, tetragonal, hexagonal, and trigonal.

The Barker Index deals with data obtained from single crystals, not with data obtained from powdered crystals, as is the case with the "ASTM, Hanawalt," method of chemical identification. The Barker Index, therefore, requires a pretty accurate knowledge of the orientation of the single crystal with respect to some base line taken from the x-ray diffraction equipment. This has required the assembly, mainly from existing literature, of large quantities of "single crystal" data. These data have been arranged in three tables, as follows: Classification angles for tetragonal, hexagonal, and orthorhombic crystals. Other data, useful in confirming conclusions reached by other methods are tabulated as follows: (1) refractive indices for tetragonal, hexagonal, trigonal, and orthorhombic crystals; (2) densities of tetragonal, hexagonal, trigonal, and orthorhombic crystals; (3) melting points of tetragonal, hexagonal, trigonal, and orthorhombic crystals.

The last half of Part 1 includes two additional tabulations—an alphabetical list of English chemical and mineralogical names, and an alphabetical list of German chemical names as used by Groth. None of the tabulations of classifications angles is made with reference to page numbers. Instead they are tabulated with reference to known quantities, such as Cr, Am, and Bq, which appear systematically in crystallographic calculations.

Part 2 is concerned entirely with crystal descriptions of 2991 compounds, making a volume 7 × 10 × 2½ in. The various crystal systems are separated by a single colored sheet. This part contains data from compounds described in the five volumes of Groth's *Chemische Krystallographie*, together with material from a few other sources, especially Donnay and Mellon's crystallochemical tables. The first 2½ pages are devoted to the scheme of description of different types of crystals, whereby a large amount of data can be compressed into a space only slightly larger than an ordinary library card. Space is also provided for auxiliary data under the headings of "forms," "habits," "physics," "optics," and "transformation." "X-ray ASTM" gives the spacings of the three strongest lines found in powder photographs.

WHEELER P. DAVEY
Research Professor Emeritus of Physics and Chemistry
The Pennsylvania State College

The Zoology of Tapeworms. Robert A. Wardle and James Archie McLeod. Minneapolis: Univ. Minnesota Press, 1952. (For the University of Manitoba.) 780 pp. and 419 illus. $12.50.

For the first time the extensive literature on cestodes, which has heretofore been published in several languages in numerous books and periodicals, is now available in English in one volume. The book is divided into two parts. Part I has the following chapter headings: "General Features," "Life Cycle," "Biology," "Origin and Evolution," "History," and "Classification." Under these topics the authors acquaint the reader with the general morphology and terminology of cestodes. Their possible origin and evolution from Turbellaria, their development, chemistry, physiology, immunology, and recent attempts in culturing cestodes are discussed. Part II comprises the larger portion of the volume and includes detailed descriptions of all known species, genera, families, and orders of Cestoda, together with keys for their identification. An extensive bibliography is compiled through the year 1950, with some 2310 references that are invaluable to the investigator with meager library facilities.

We do not agree with some of the opinions and interpretations voiced by the authors throughout the text. Only two of these items will be mentioned here because of lack of space. First, that the Tetraphyllidea are more primitive than the Pseudophyllidea is only a matter of opinion; there is just as good evidence that the reverse is true. Second, that there are 17 orders of cestodes is a matter of interpretation of the facts at hand. Few helminthologists will agree on a classification of cestodes. We consider it reactionary to base ordinal characters on that highly variable organ, the scolex. A case in point is that of the order Trypanorhyncha. It was erected by European workers to include cestodes with a scolex possessing bothria and proboscides, at a time when the life cycle was unknown. The authors recognize that it is a highly controversial order and that its only known life cycle is pseudophyllidean in character, yet fail to merge it with the Pseudophyllidea. They do retain in this last-named order a similar worm, *Haplobothrium globuliforme*, which, according to most American parasitologists, is properly placed.

This is a provocative book which should awaken students to the vast array of cestode problems yet unsolved. It should prove useful to zoologists, physiologists, and parasitologists, as well as to physicians and veterinarians.

LYELL J. THOMAS
Department of Zoology, University of Illinois

Scientific Book Register

A Guide to the History of Science. A first guide for the study of the history of science, with introductory essays on science and tradition. George Sarton. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1952. 316 pp. $7.50.

Statistical Theory with Engineering Applications. A. Hald; trans. by G. Seidelin. New York: Wiley; London: Chapman & Hall, 1952. 783 pp. $9.00.

Statistical Tables and Formulas. A. Hald. New York: Wiley; London: Chapman & Hall, 1952. 97 pp. $2.50.

Theory of Superconductivity. M. von Laue; trans. by Lothar Meyer and William Band. New York: Academic Press, 1952. 140 pp. $4.00.

The Apologie and Treatise of Ambroise Paré. Containing the Voyages Made into Divers Places with Many of His Writings upon Surgery. Geoffrey Keynes, Ed. Chicago: Univ. Chicago Press, 1952. 227 pp. $3.50.

Advances in Catalysis and Related Subjects, Vol. IV. W. G. Frankenburg, V. I. Komarewsky, and E. K. Rideal, Eds. New York: Academic Press, 1952. 457 pp. $9.50.

A World Dictionary of Breeds, Types and Varieties of Livestock. I. L. Mason. Farnham Royal, Bucks, Eng.: Commonwealth Agricultural Bureaux, 1951. 272 pp. 30s.

Flora of Guatemala, Part III. Paul C. Standley and Julian A. Steyermark. Chicago: Chicago Natural History Museum, 1952. 432 pp. $4.50.

Bacteria. Stanley Thomas and Thomas H. Grainger. Philadelphia–Toronto: Blakiston, 1952. 623 pp. $5.50.

The Sources and Nature of the Statistics of the United Kingdom, Vol. I. Maurice G. Kendall, Ed. London–Edinburgh: Oliver and Boyd, 1952. (Published for The Royal Statistical Society.) 352 pp. 21s.

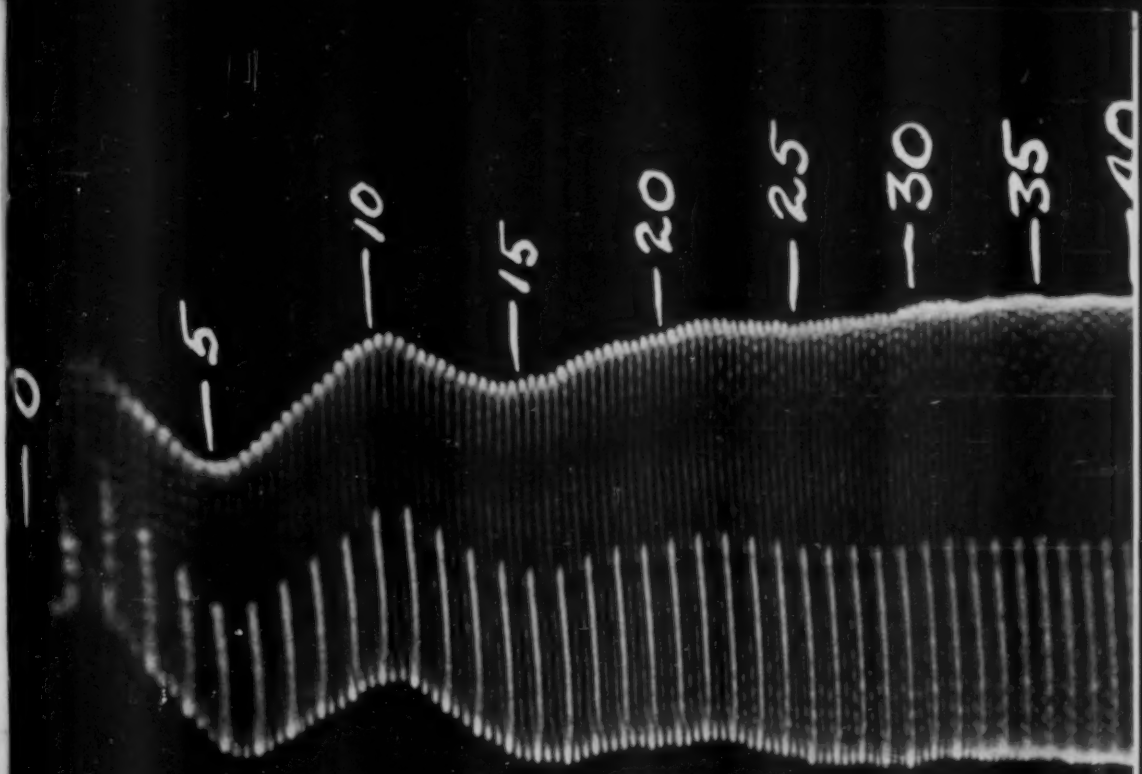
Advances in Medicine and Surgery from the Graduate School of Medicine of the University of Pennsylvania. Philadelphia–London: Saunders, 1952. 441 pp. $8.00.

The Living Body: A Text in Human Physiology. 3rd ed. Charles Herbert Best and Norman Burke Taylor. New York: Holt, 1952. 792 pp. $5.50.

Analytical Mechanics for Engineers. 4th ed. Fred B. Seely and Newton E. Ensign. New York: Wiley; London: Chapman & Hall, 1952. 443 pp. $5.50.

Probit Analysis: A Statistical Treatment of the Sigmoid Response Curve. 2nd ed. D. J. Finney. New York–London: Cambridge Univ. Press, 1952. $7.00.

Primer of Electronics and Radiant Energy. 2nd ed. Don Caverly. New York–London: McGraw-Hill, 1952. 343 pp. $5.50.



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Approaches to Problems of High Fertility in Agrarian Societies. Papers presented at the 1951 annual conference of the Milbank Memorial Fund. New York: Milbank Memorial Fund, 1952. 171 pp. $1.00.

The Consulting Chemist and Chemical Engineer in a World Economy. New York: Assoc. Consulting Chemists and Chem. Engrs., 1952. 32 pp. Illus. $1.00.

Contributions to the Analysis and Synthesis of Knowledge. Proc. Am. Acad. Arts Sciences, 80, (1). Published in cooperation with the Institute for the Unity of Science. Philipp Frank *et al.* Boston, Mass.: Committee on Publication, American Academy of Arts and Sciences, 1951. 112 pp. $2.00.

Germany's New Nazis. Prepared by the Anglo-Jewish Association. New York: Philosophical Library, 1952. x + 76 pp. $2.75.

A Guide to Filter Paper and Cellulose Powder Chromatography. Compiled by J. N. Balston and B. E. Talbot; Tudor S. G. Jones, Ed. New York: H. Reeve Angel & Co., Inc., 1952. 145 pp.

Illness and Health Services in an Aging Population. Four papers presented in Section IV of the Second International Gerontological Congress, St. Louis, Mo., Sept. 9–14, 1951. Federal Security Agency Public Health Service Pub. No. 170. G. St. J. Perrott, Antonio Ciocco, George Baehr, Leonard S. Rosefeld, and collaborators. Washington, D. C.: GPO, 1952. 68 pp. 25¢.

Industry and Government Research. Addresses given at 56th Congress of American Industry, New York, Dec. 7, 1951. Economic Policy Division Series, No. 50. New York: Nat. Assoc. Manuf. 19 pp.

A List of British Mammals. T. C. S. Morrison-Scott. 24 pp. 2s. *The Sub-Genus Stegomyia (Diptera: Culicidae) in the Ethiopian Region,* Part I, Vol. 2, No. 5. P. F. Mattingly. London: British Museum (Natural History), 1952. Pp. 233–304 + 16 text figures. 15s.

Manual of Biology, Part I: *The Protozoa and the Plants;* Part II: *The Metazoan Animals.* Rev. ed. Douglas Marsland. New York: Holt, 1952. Pt. I: 162 pp., $2.00; Pt. II: 207 pp., $2.20.

Metabolism and Function in Nervous Tissue. Biochemical Society Symposia No. 8. R. T. Williams, Ed. New York: Cambridge Univ. Press, 1952. 102 pp. $2.75.

The National Formulary 1952. London: Brit. Med. Assoc. or Pharmaceutical Press. 196 pp. 4/6 (postage, 3d.); interleaved, 7/6 (postage, 5d.).

Plants and the Atmosphere. Case 5. Harvard Case Histories in Experimental Science, James Bryant Conant, Ed. Leonard K. Nash. Cambridge, Mass.: Harvard Univ. Press; London: Oxford Univ. Press, 1952. 122 pp. $1.50.

Possible Sumerian Survivals in Toda Ritual. Bull. of the Madras Government Museum, General Section, Vol. VI, No. 1. H. R. H. Prince Peter of Greece. Madras: Government Press, 1951. xvi + 24 pp. + plate. 6 Rs. 4 annas.

Statistical Method in Industrial Production. Papers Given at a Conference Held in Sheffield in 1950. London: Royal Statistical Society, 1951. 89 pp. Illus. 7s. 6d.

Teaching Methods in Public Health Nursing. Kathleen M. Leahy and Aileen Tuttle Bell. Philadelphia–London: Saunders, 1952. 220 pp. $3.50.

Textbook of Neurosurgical Nursing. Walter G. Haynes and Mary McGuire. Philadelphia–London: Saunders, 1952. 178 pp. $3.50.

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July 15–18. International Society of Geographic Pathology. Liége, Belgium.
July 16–18. Institute of the Aeronautical Sciences (Annual). Los Angeles.
July 16–19. Silver Bay Conference on Human Relations in Industry. Auditorium, Silver Bay, N. Y.
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Tracerlab is very pleased, in this period of short supply of instruments, to be able to make immediate delivery on the widely-used SC-7 "100" Scaler. Because of fortunate purchases of component parts, a limited number of these scalers is now available for shipment. Orders, however, should be placed promptly.

The "100" Scaler is a direct reading "conventional" scaler which indicates the number of counts received during an arbitrary length of time. It utilizes two SC-11 Decasale plug-in units based on four cascaded scales of two with two feedback loops to provide a scale of ten. A Wizard Register capable of recording up to 600 evenly spaced counts per minute, makes it possible to count as many as 60,000 evenly spaced impulses per minute. The start-stop switch will also actuate a separate clock such as the SM-60A Electric Timing Clock.

The instrument has been designed to require a minimum of service, with all components overdesigned so that every part is rated for service in excess of that required for normal usage. *For further information, request bulletin XX-38.*

Tracerlab
130 HIGH ST., BOSTON, MASS.

BERKELEY, CAL. — WASHINGTON, D. C.
NEW YORK, N. Y. — CHICAGO, ILL.

PROBLEM: Air headache

ANSWER: Headaches haunted military pilots prior to World War
Just being up in the air was blamed for the trouble. T
someone suspected the goggles and put them on non-flying p
sonnel as a test. Their heads ached, too. The problem was
up to scientists at American Optical Company. They worked
a corrected lens formula solving the problem for the Air Co

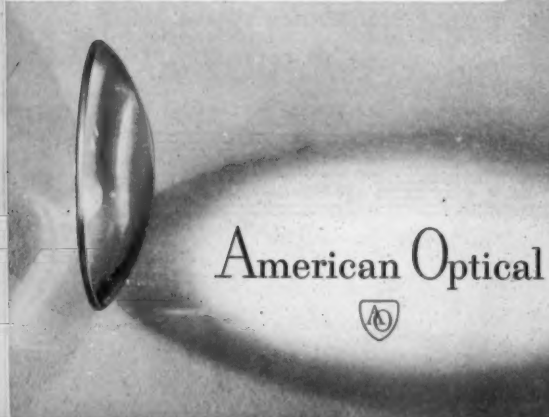
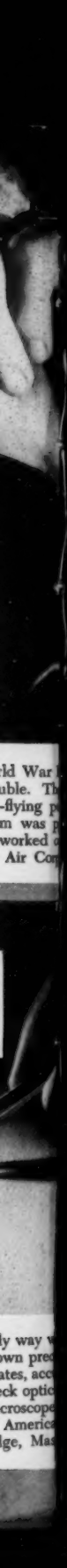
PROBLEM: A surer test for tuberculosis

MAGNIFIED 350 TIMES

ANSWER: Formerly, TB bacteria were hard to see even under a powerful microscope. Now, by an improved technique, TB bacteria are made to fluoresce under ultraviolet light — glow yellow against a dark background. Their presence is more easily detected. American Optical scientists helped develop this speedy, accurate method of searching.

PROBLEM: Accuracy to a millionth of an inch

ANSWER: Optical lenses *must* be accurate. The only way
could achieve such accuracy was to make our own pre
sion checking instruments... interference test plates, acc
rate to one millionth of an inch. Test plates check optic
surfaces in contour projectors, spectrometers, microscope
Write us about your development problems. Americ
Optical Company, 86 Vision Park, Southbridge, Ma



American Optical